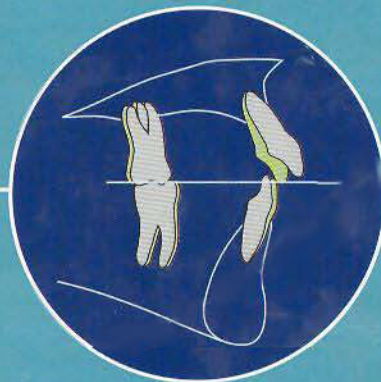
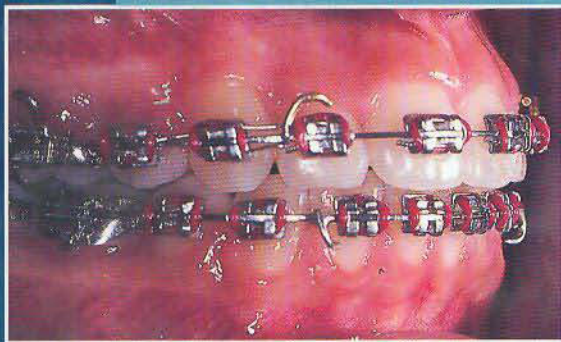
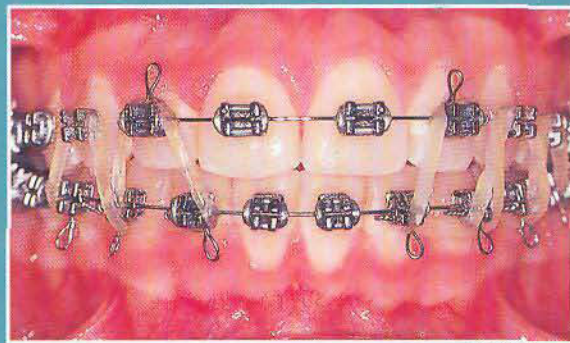
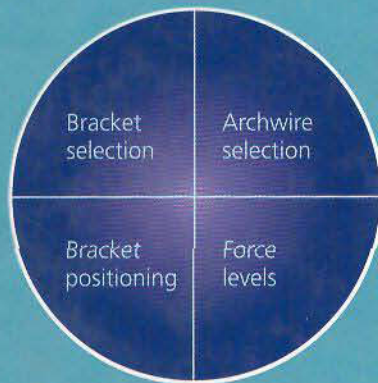


By ORTHOTAMINE

SYSTEMIZED ORTHODONTIC TREATMENT MECHANICS

McLaughlin • Bennett • Trevisi



VISIT...

LANZAROTE
Caliente.COM

www.allislam.net

Problem

Systemized orthodontic treatment mechanics

Richard E. Johnston, D.D.S.

Professor of Orthodontics, University of Michigan

John C. Burdette, D.D.S.

Professor of Orthodontics, University of Michigan

Hugo J. D'Souza, D.D.S.

Professor of Orthodontics, University of Michigan

RA Mosby

Systemized orthodontic treatment mechanics

Richard P McLaughlin

San Diego, California, USA

John C Bennett

London, UK

Hugo J Trevisi

Presidente Prudente, Brazil

 **Mosby**

EDINBURGH LONDON NEW YORK PHILADELPHIA ST LOUIS SYDNEY TORONTO 2001

MOSBY

An imprint of Harcourt Publishers Limited

© Mosby International Ltd 2001

M is a registered trademark of Harcourt Publishers Limited

The right of Dr Richard P McLaughlin, Dr John C Bennett and Dr Hugo J Trevisi to be identified as authors of this work has been asserted by them in accordance with the Copyright, Designs and Patents Act 1988

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without either the prior permission of the publishers (Permissions Manager, Harcourt Health Sciences, Robert Stevenson House, 1-3 Baxter's Place, Leith Walk, Edinburgh EH1 3AF), or a licence permitting restricted copying in the United Kingdom issued by the Copyright Licensing Agency, 90 Tottenham Court Road, London W1P 0LP.

First published 2001

ISBN 072343171X

British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library

Library of Congress Cataloging in Publication Data

A catalog record for this book is available from the Library of Congress

Typeset by IMH(Cartrif), Loanhead, Scotland
Printed in Spain

The
publisher's
policy is to use
paper manufactured
from sustainable forests

PREFACE AND ACKNOWLEDGEMENTS

Goal-directed orthodontic treatment is extremely important. If the goals of treatment goals are not kept in mind from the diagnosis and treatment-planning phase through to the phase of retention, continuous errors can be made. Treatment then becomes inefficient and results are disappointing. However, if treatment goals are kept constantly in mind, results become much more consistent, and when minor compromises must occur, the reasons for these can be understood, and many of them can be avoided in the future. The goals of treatment for the authors are listed below. They hope the reader will keep these in mind when reading the text, to provide greater insight into their intent. It is hoped that in that way it will have more meaning. The treatment goals are:

- Condyles in a seated position – in centric relation
- Relaxed healthy musculature
- A 'six keys' Class I occlusion
- Ideal functional movements – a mutually protected occlusion
- Periodontal health
- Best possible aesthetics.

This book was originally planned as a second edition of the first Bennett and McLaughlin text, entitled *Orthodontic Treatment Mechanics and the Preadjusted Appliance*, published in 1993. However, there have been so many technological changes and improvements over the past 8 years that an entirely new text became necessary, supplementing the general message of the first.

A second Bennett and McLaughlin text, entitled *Orthodontic Management of the Dentition with the Preadjusted Appliance*, was published in 1997. This devoted a chapter to each tooth in the dentition, emphasizing clinical situations relating to each tooth. It evolved into a far more extensive project than initially intended, and required a substantial manuscript to cover the wide range of material.

With this third textbook, the intention is to return to a concise format somewhat similar in scope to the first. Its primary focus is on orthodontic treatment mechanics, in particular intra-arch considerations, or the maneuvers involved in alignment and maintenance of the dentition in each individual arch. These factors are dealt with in Chapter 5 'Anchorage control during tooth leveling and aligning', Chapter 6 'Arch leveling and overbite control', Chapter 9 'Space closure and sliding mechanics', and Chapter 10 'Finishing the case'. Inter-arch considerations, or the

coordination of the upper and lower arches in three planes of space within the facial complex, are also given a slightly greater emphasis than previously; in particular, Chapter 7 and 8 deal with Class II treatment and Class III treatment, respectively. These are extensive subjects, but an attempt has been made to present a concise and up-to-date perspective on the general management of these two categories of case.

The text discusses both extraction and non-extraction treatments. Greater emphasis is placed on extraction treatment, because the mechanics of these cases are more complex. This is not to infer that the authors treat more cases on an extraction basis; in general, every effort is made to treat on a non-extraction basis wherever possible, and the authors treat a much higher percentage of cases in this manner.

After using the original 'Straight-Wire® Appliance' (SWA) for nearly 20 years, it became important to provide modifications to the appliance to more closely complement modern treatment mechanics. Chapter 2 on appliance specification deals with the rationale behind the changes made in the appliance system. Emphasis is placed on the new variations, as well as on the versatility of the appliance (comparisons are restricted to the original SWA and do not refer to other orthodontic appliances).

A bracket placement chart, developed in 1995, has been most valuable in the important area of bracket placement. The text discusses recent developments in bracket-placement techniques – renewed interest in indirect bonding, for instance, has occurred because of improved materials, such as adhesive systems and tray materials. An overview of this subject is provided.

Archwire technology has improved dramatically over the past 8 years. The use of heat-activated nickel-titanium wires (HANT) has become a vital part of the treatment system, and, consequently, modifications to the treatment mechanics have occurred. Information on HANT wires, along with a discussion of archwire sequencing, is presented in Chapter 5 'Anchorage control during tooth leveling and aligning'.

Since its introduction in the 1970s, attempts have been made with the preadjusted appliance to select and use a single arch form on most patients. Even using the most frequently observed arch form in the orthodontic population, the authors observed numerous cases that were either too narrow or over-expanded. Therefore, Chapter 4 is dedicated to the subject of arch form, and presents efficient techniques for managing arch form selection and archwire coordination.

Chapter 11 is dedicated to retention protocol, which is a new subject for this text. It gives an overview of the protocol, as well as describing the methods most frequently used by the authors.

Drs Bennett and McLaughlin have spent a great deal of time with Dr Hugo Trevisi of Presidente Prudente, Brazil, who has used this system of treatment for over 20 years. Dr Trevisi has provided a number of important insights into the technique, and therefore a decision was made to introduce him as a third author of the text, thus reinforcing its international perspective, and bringing together the best ideas from three continents.

The success of a project of this scope and complexity depends on the commitment of many individuals. The authors acknowledge and appreciate the documentation skills and extra photography carried out by the assistants in each of the authors' practices. The work of Patty Knecht and Laura Plante in San Diego, and Cath West in London, was invaluable, as were the interpreting skills of Michelle Trevisi Araujo in Brazil.

Text and illustrations were assembled in London, and production and publication were handled by the Mosby team in Edinburgh. On behalf of the publishers, Barbara Simmons, project development manager, and her colleagues contributed unfailing energy and enthusiasm to this project. Their professionalism and respect of the authors' sometimes unconventional work patterns helped make the publishing process both efficient and enjoyable. The authors freely acknowledge the valuable help and advice given by Michael Parkinson, commissioning editor. They also wish to make

particular mention of the contribution of Graham Birnie, who laboriously checked and edited the original text, and of Judith Wright, who was responsible for the design. Looking ahead, there are plans for at least 12 foreign co-editions, and the authors are grateful to Ilona Turniak for her work on this important aspect of publication.

Chapters 7 and 8 include information on the diagnostic methods of Dr Bill Arnett, who gave considerable time and assistance, and made important material available for Chapter 8. The authors are also grateful for Dr Fredrik Bergstrand's advice on bonding, and for the photograph. The authors' work has benefited over the course of many years from the input of international colleagues – although space constraints make it impossible to acknowledge each individually, their friendship, enthusiasm and support does not go unrecognized.

The following technical production information may be of interest. The original text was generated in Apple Works 5.0 on a Macintosh G4 computer. Line drawings were created in Apple Freehand 8.0, and teeth are represented approximately to scale, with form based on dental anatomy texts. The color photographs were mainly originated in Kodachrome 64. No digital enhancement of clinical material took place. Apart from the removal of red-eye on some of the facial photographs, it has been published directly from the original Kodachrome slides.

Finally, the authors would like to thank 3M Unitek for its efforts in designing the new appliance, as well as for support in the other areas of the treatment system, such as bracket-placement gauges and charts.

CONTENTS

1. A brief history and overview of treatment mechanics 1
 2. Appliance specifications – variations and versatility 25
 3. Bracket positioning and case set-up 55
 4. Arch form 71
 5. Anchorage control during tooth leveling and aligning 93
 6. Arch leveling and overbite control 129
 7. An overview of Class II treatment 161
 8. An overview of Class III treatment 217
 9. Space closure and sliding mechanics 249
 10. Finishing the case 279
 11. Appliance removal and retention protocols 305
- Index 319

A brief history and overview of treatment mechanics

Introduction	3	The work of McLaughlin, Bennett, and Trevisi between 1993 and 1997	8
Fundamentals of treatment mechanics	3	Re-designed bracket system – MBT™	
Bracket design		Improved bracket positioning with gauges	
Bracket positioning		The work of McLaughlin, Bennett, and Trevisi between 1997 and 2001	12
Archwire selection		The decision to use three arch forms	
Force levels		Updated light forces and sliding mechanics	
The work of Andrews	4	Overview of the MBT™ treatment philosophy	13
Wide range of brackets		Bracket selection	13
Center of the crown		Versatility of the bracket system	13
Various arch forms		Accuracy of bracket positioning	13
Heavy forces		Light continuous forces	13
The work of Roth	6	The .022 versus the .018 slot	14
Roth brackets		Anchorage control early in treatment	15
Center of the crown		Group movement	16
Wide arch form		The use of three arch forms	16
Articulators		One size of rectangular steel wire	17
McLaughlin and Bennett 1975 to 1993	7	Archwire hooks	18
Mainly standard brackets		Methods of archwire ligation	20
Center of the crown		Awareness of tooth size discrepancies	21
Ovoid arch form		Persistence in finishing	21
Light forces and sliding mechanics		Case SS	22

INTRODUCTION

Andrews published his landmark article¹ in 1972, and subsequently designed an appliance based on his findings. However, soon after the introduction of the preadjusted appliance, it became clear that the bracket system required a whole new program of treatment mechanics and force levels to fully realize its potential. In turn, the new treatment mechanics and force levels brought about a need for modifications to the bracket system. Ultimately, it has become the mechanics and force levels that have determined the appliance design, and not vice versa. This chapter reviews the evolution of orthodontic treatment mechanics since the early 1970s (the start of the modern era), and goes on to review the principles of the method currently used.

Appliance design and treatment mechanics are closely inter-related. To some extent, bracket design can be scientific and based on research, so that bracket designs can be produced in a matter of months. However, development and refinement of appropriate treatment mechanics take years, and have to be based on experience with numerous treated cases. Consequently, the information on treatment mechanics is often anecdotal, and based on recommendations from experienced clinicians. Even well-structured investigations into treatment efficiency tend to be inconclusive.^{2,3}

FUNDAMENTALS OF TREATMENT MECHANICS

Orthodontic treatment mechanics are determined by four elements – bracket selection, bracket positioning, archwire selection, and force levels (Fig. 1.1). If a balanced combination of these elements is used, efficient and systemized treatment can be achieved. However, variation in one (for example archwire selection) can substantially influence the other elements and can undermine the effectiveness of the treatment approach.

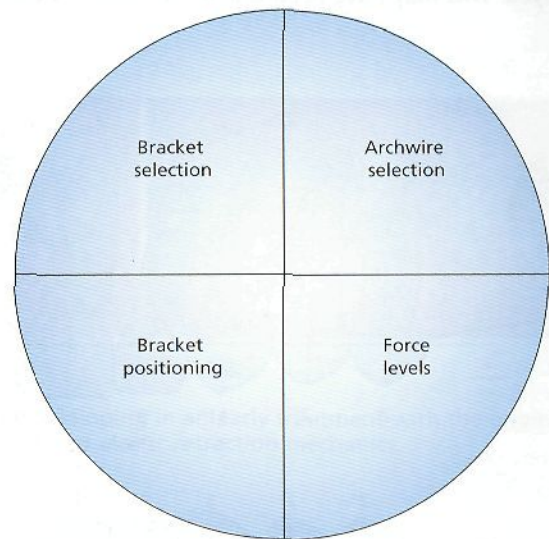


Fig. 1.1 Orthodontic treatment mechanics are determined by four elements.

THE WORK OF ANDREWS

Andrews is rightly regarded as the father of the preadjusted bracket system, and it is interesting to review his contribution in the light of experience over the last 25 years of clinical use.

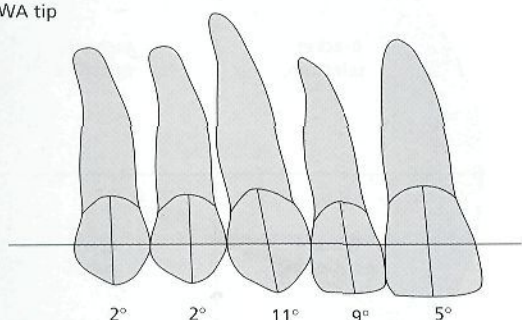
When the original Straight-Wire Appliance® (SWA) became available in 1972, it was based on science, but included many of the traditional features of siamese edgewise brackets. Andrews' paper was based on the measurement of 120 non-orthodontic normal cases. He then used the data as a basis to design a bracket system.

Although the SWA was radically new, traditional heavy edgewise forces continued to be used. No special anchorage control measures, such as second order archwire bends, were employed. This may have been due to his clinical experience

as an edgewise orthodontist and the force levels that were used. He also emphasized the 'wagon wheel effect' where tip was lost as torque was added. Hence, he chose to add additional tip to the anterior brackets. (Fig. 1.2).

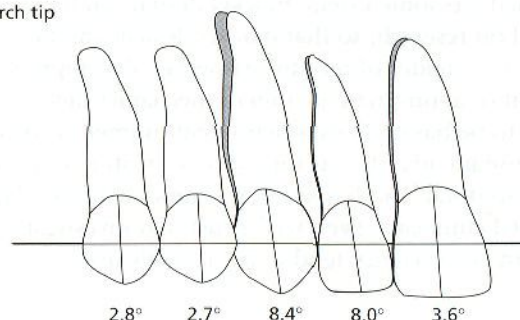
Bracket positioning was based on the center of the clinical crown. Because less wire bending was needed with the new appliance, there was also a trend to standardize arch form. As a result of Roth's influence, there was a general movement toward a broad or square arch form, although Andrews continued to use the basal bone of the mandible as an arch form reference. Various arch forms were used because no clear direction was available.

SWA tip



SWA tip

Research tip



Research tip

Fig. 1.2 The original Straight-Wire Appliance® (SWA) was based on measurement of 120 non-orthodontic normal cases, although extra tip was built into the anterior brackets.

Difficulties were encountered with treatment mechanics in the early years, due to the heavy forces and possibly due to the increased tip in the anterior brackets. Consequently, deepening of the anterior bite, with creation of a lateral open bite, was seen in many cases, and this became known as the 'roller coaster' effect (Figs 1.3–1.6).

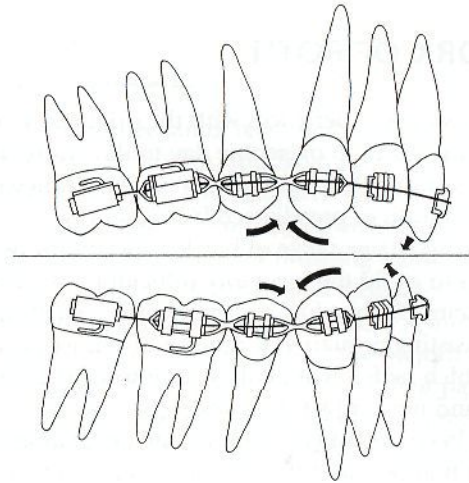


Fig. 1.3 In the early years of the preadjusted appliance, heavy forces were used, and these were associated with deepening of the anterior bite and creation of a lateral open bite which became known as the 'roller coaster' effect.



Fig. 1.4

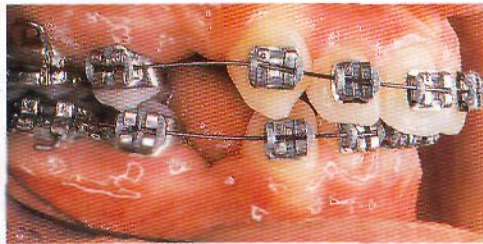


Fig. 1.5

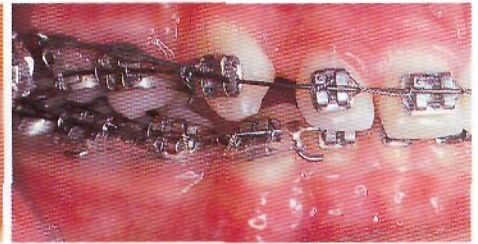


Fig. 1.6

Figs. 1.4 to 1.6 The treatment sequence above shows the 'roller coaster' effect developing in an early treatment with the original SWA. The unwanted deepening of the overbite was due to excess force and the use of elastic retraction mechanics.

These early clinical experiences led Andrews to introduce a series of modifications, and after using the original 'standard' Straight-Wire Appliance® for a period of time, he recommended a wide range of brackets. For example, he determined that for extraction cases, canine brackets with anti-tip, anti-rotation and power arms were needed (Fig. 1.7). He also recommended the use of three different sets of incisor brackets, with varying degrees of torque for different clinical situations.

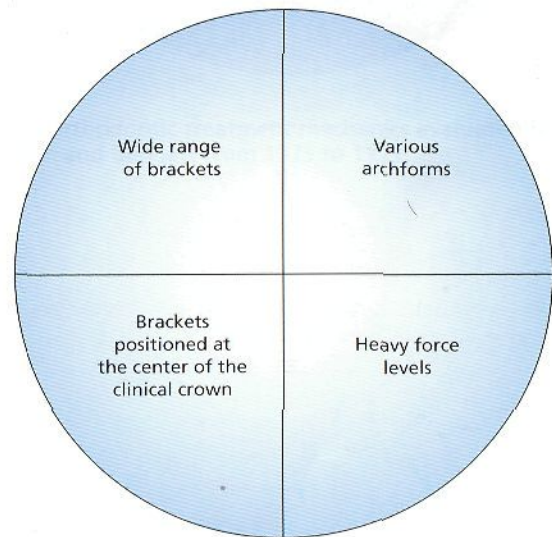


Fig. 1.7 Orthodontic treatment mechanics in the early years of the SWA.

THE WORK OF ROTH

Following his early experiences with the original SWA, Roth introduced measures to overcome day-to-day shortcomings which he had found in clinical use. Whereas Andrews, with the first generation of preadjusted brackets, was recommending a large range of bracket specifications, Roth was anxious to avoid the inventory difficulties of a multiple bracket system. He therefore recommended a single appliance system, consisting primarily of minimum extraction series brackets, which he felt would allow him to manage both extraction and non-extraction cases.

This has been described as the second generation of preadjusted brackets, and Roth's recommendations were widely accepted by clinicians, some of whom had experienced similar difficulties in treatment mechanics and were confused by the wide variety of available brackets. The appliance prescriptions developed by Andrews and Roth were based on the overall treatment mechanics used in their practices.

The Roth treatment approach emphasized the use of articulators for diagnostic records, for early splint construction, and for the construction of gnathological positioners at the end of treatment (Fig. 1.8). This approach was used to aid in establishing correct condyle position. He used the center of the clinical crown for bracket positioning, as advocated by Andrews. As stated above, his arch form was wider than Andrews' in order to avoid damage to canine tips during treatment and to assist in obtaining good protrusive function.

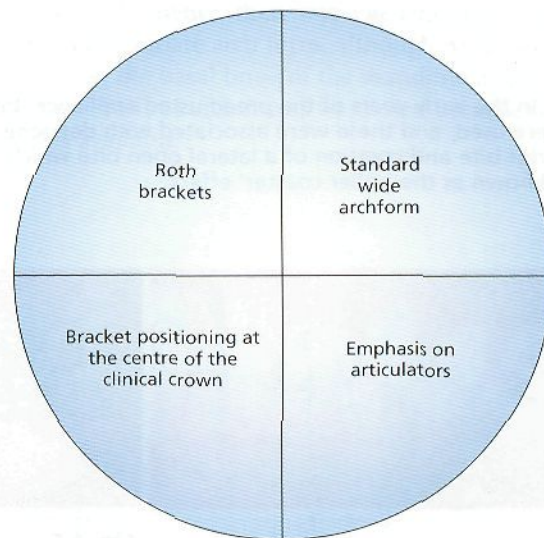


Fig. 1.8 Roth selected a range of brackets to create a single appliance system.

THE WORK OF McLAUGHLIN AND BENNETT BETWEEN 1975 AND 1993

Although they evaluated many bracket variations, including the Andrews' 'translation' series, in the period 1975 to 1993 McLaughlin and Bennett preferred to work mainly with the standard SWA bracket system. Instead of initially modifying the basic bracket design, for more than 15 years they developed and refined treatment mechanics based on sliding mechanics and continuous light forces, mainly using standard SWA brackets. These mechanics were published initially as a series of papers in the early 1990s^{4,5,6} and then as a book in 1993⁷ (Fig. 1.9) and have seen widespread acceptance.

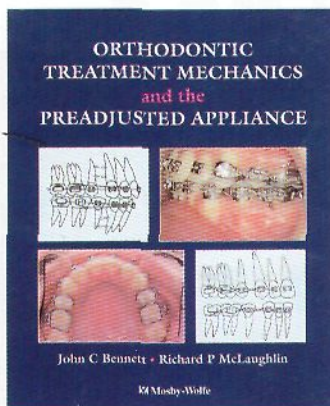


Fig. 1.9 *Orthodontic Treatment Mechanics and the Preadjusted Appliance* was published in 1993.

Their treatment mechanics recommendations included accurate bracket positioning, and lacebacks and bendbacks for early anchorage control, with light archwire forces (Fig. 1.10). Sliding mechanics were recommended on .019/.025 steel rectangular wires, with light .014 finishing wires.

They used the middle of the clinical crown for bracket positioning during this development period. A medium-sized standard ovoid arch form was used for the majority of cases, and the size reflected the fact that many of their patients were children with malocclusions, unlike Andrews' sample of 120 normals, which were non-extraction adults with large arches.

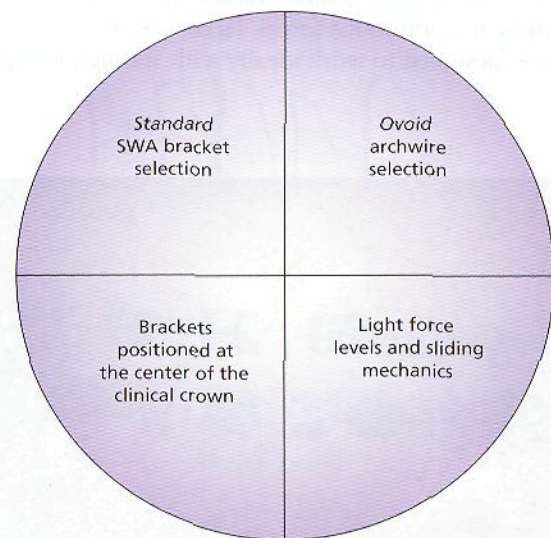


Fig. 1.10 Orthodontic treatment mechanics evaluated by McLaughlin and Bennett from 1975 to 1993.

THE WORK OF McLAUGHLIN, BENNETT, AND TREVISI BETWEEN 1993 AND 1997

Having established an overall approach and a successful system of treatment mechanics using the preadjusted bracket system in its standard form, McLaughlin and Bennett then worked with Trevisi to re-design the entire bracket system to complement their proven treatment philosophy and to overcome the perceived inadequacies of the original SWA. They re-examined Andrews' original findings, and took into account additional research input from Japanese sources^{8,9} when designing the MBT™ bracket system.

This third-generation bracket system retained all that was best in the original design, but at the same time introduced a range of improvements and specification changes to overcome the clinical shortcomings. Its design was based on a balance of basic science and many years of clinical experience. MBT™ is a version of the preadjusted bracket system specifically for use with light, continuous forces, lacebacks and bendbacks, and it was designed to work ideally with sliding mechanics.

The original system of dots and dashes was superseded by laser numbering of standard size metal brackets, and the rectangular shape was replaced by the rhomboidal form. This reduced the bulk of each bracket and coordinated perspective lines through only two planes, thereby assisting accuracy of bracket placement. The bracket system was made available in standard metal (Fig. 1.11), mid-sized, and clear forms (Fig. 1.12). It had sufficient versatility to deal with most clinical situations, and to limit inventory levels.

As previously stated (p. 4), the anterior tip specifications for the original SWA were all greater than the research findings. Additional tip had been built in, over and above the scientific means. For example, the important upper canine carried 11° in the first-generation (SWA) and then 13° in the second-generation (Roth)¹⁰ system, compared with the research finding of 8°.

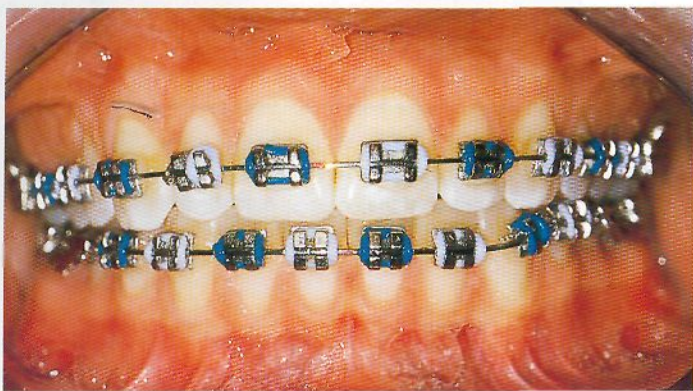


Fig. 1.11 Standard metal MBT™ brackets give optimal tooth control.



Fig. 1.12 This case has Clarity™ brackets on the upper anterior teeth and mid-sized metal brackets on the lower anterior teeth. The three different bracket options of standard metal, mid-sized metal and clear forms may be used in combination for the same patient.

Additional anterior tip was a disadvantage for three reasons:

1. It created a significant drain on antero-posterior (A/P) anchorage.
2. It increased the tendency to bite deepening during the alignment stage.
3. It brought the upper canine root apex too close to the first premolar root in some cases.

As lighter forces were being used in all stages of treatment, this additional 'anti-tip', or second-order compensation, was not needed. Therefore, when designing the MBT™ bracket

system, it was decided to base the anterior tip on the original research values. These assist treatment mechanics because they reduce the anchorage control needs, reduce the tendency to bite deepening in the early stages of treatment, and put less demand on patient cooperation. When the original research values for tip are used for incisors and canines, a total of 10° less distal root tip in the upper anterior segment and 12° less distal root tip in the lower anterior segment is needed, compared with the original SWA (Fig. 1.13). As the MBT™ measurements are based on Andrews' original research figures, there is no compromise in ideal static occlusion. And if the condyles are in centric relation, there is no compromise in ideal functional occlusion as described by Roth.

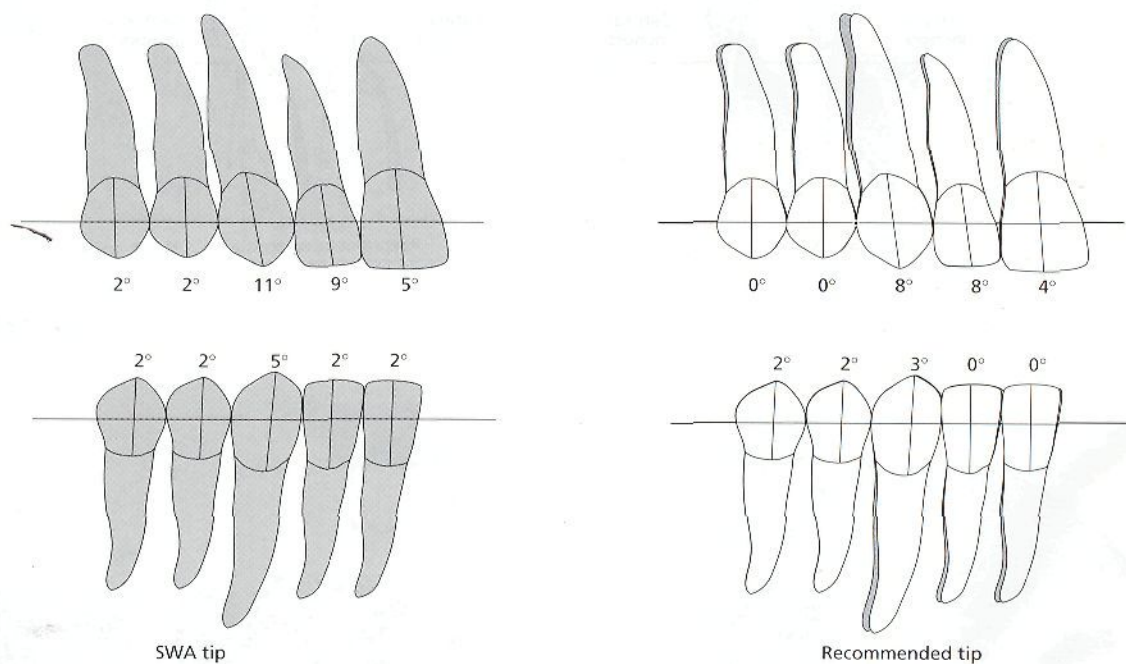


Fig. 1.13 The recommended tip measurements for the MBT™ bracket system are based on Andrews' original research figures, and these features give less distal root tip in the upper and lower anterior segments.

The preadjusted appliance system is a development of the edgewise bracket, which is relatively inefficient in delivering torque. When designing the MBT™ bracket system, it was therefore necessary to build extra torque into the important incisor and molar regions in order to meet clinical goals in these areas with a minimum of wire bending (Figs 1.14 & 1.15). This design feature helps to overcome the fundamental shortcoming of the original edgewise bracket.

Brackets with three options for canine torque were needed to deal with different patient arch forms and other clinical

variables. Andrews' research finding of -7° torque in the upper canines, and a reduced torque figure of -6° (from -11°) in the lower canines, is satisfactory for the canines in many cases. However, a typical orthodontic caseload is a different sample from the 120 non-extraction adults. Hence there is a need for three canine torque options.

It was decided that upper canine brackets would be available with -7° , 0° and $+7^\circ$ torque values in the new MBT™ system, because versatility was needed. The 0° and $+7^\circ$ options are preferred for cases with narrow maxillary bone

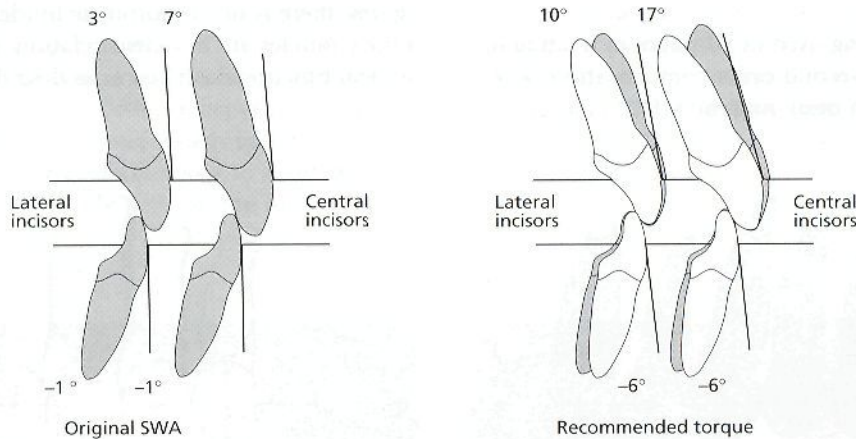


Fig. 1.14

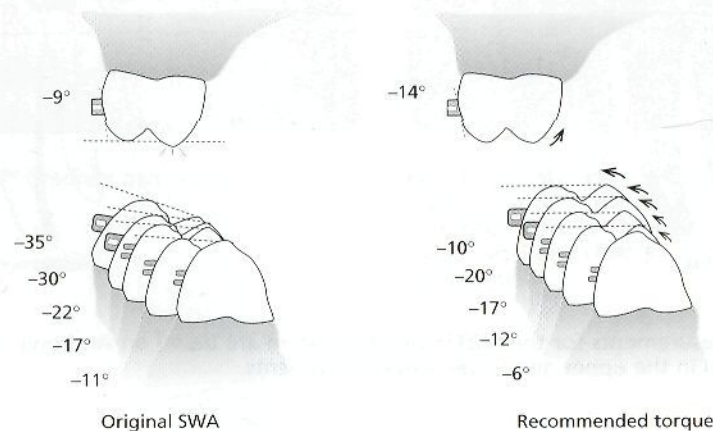


Fig. 1.15

Figs. 1.14 and 1.15 Extra torque was built in to the MBT™ bracket system in the important incisor and molar regions compared with the original SWA.

form and/or prominent canine roots (Fig. 1.16). Lower canine torque is -6° , but 0° or even $+6^\circ$ is available for some cases (Fig. 1.17), if needed.

In the period from 1993 to 1997, McLaughlin and Bennett also revised their recommendations on bracket positioning, to improve vertical accuracy. In the early years, they had used the middle of the clinical crown for bracket positioning, but they

subsequently¹¹ developed a better system. This accepted the principles advocated by Andrews, but also used gauges to ensure greater vertical accuracy (p. 62). Their work on the revised bracket designs and the new bracket positioning technique was incorporated into a second book,¹² published in 1997 (Fig. 1.18).

Fig. 1.16

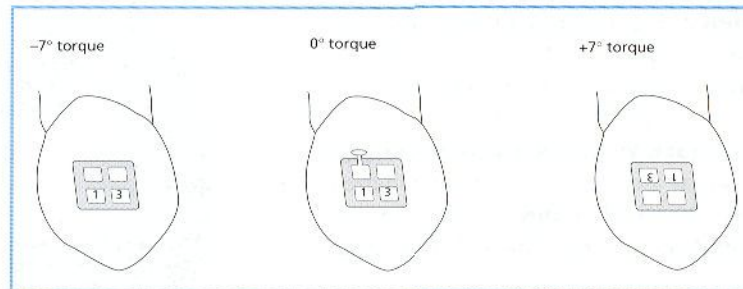
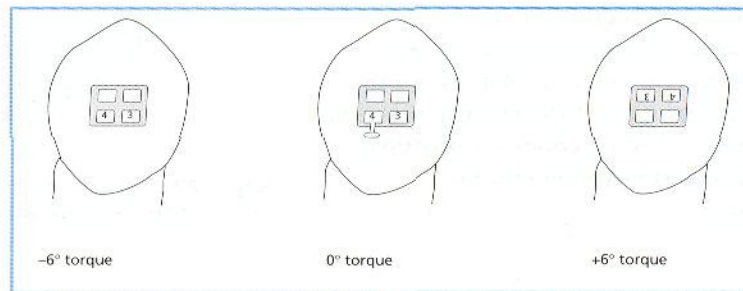


Fig. 1.17



Figs. 1.16 and 1.17 Versatility was needed for canine torque, and therefore three options were made available for upper and lower canines.

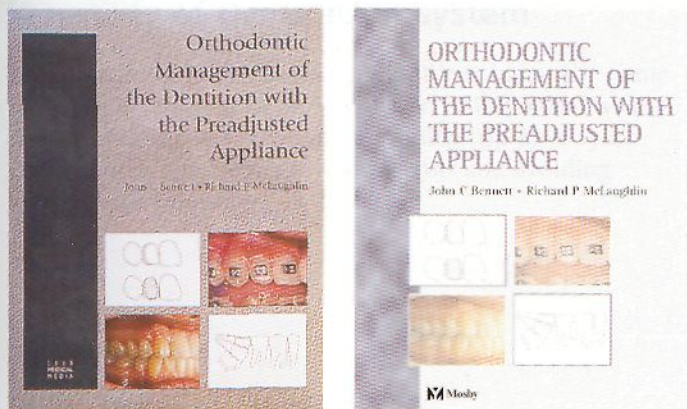


Fig. 1.18 *Orthodontic Management of the Dentition with the Preadjusted Appliance* was published in 1997 and is scheduled to be republished in January, 2002.

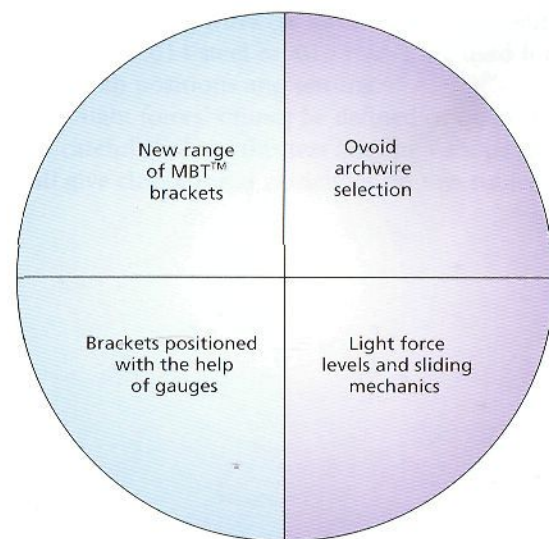


Fig. 1.19 Orthodontic treatment mechanics developed by McLaughlin, Bennett, and Trevisi up to 1997.

THE WORK OF McLAUGHLIN, BENNETT, AND TREVISI BETWEEN 1997 AND 2001

In order to complete a modern systemized method of treatment mechanics, it became necessary to address the subjects of archwire selection and force levels.

Although an ovoid arch form had proved useful in the early years, because of previous and current arch form research, it was recommended (Fig. 1.20) that three basic shapes of arch form – tapered, square, and ovoid – would be required (p. 74). When superimposed, they vary mainly in inter-canine and inter-premolar width, giving a range of approximately 6 mm. Inter-molar widths of the three shapes are quite similar, but the molar areas of wires can be widened or narrowed as needed, by easy wire bending. Recommendations were published concerning arch form and archwire selection.¹³

This third book brings all the four treatment mechanics essentials together. It covers bracket design, bracket placement, and archwire selection, and it re-defines force levels (for example to incorporate recommendations for the use of heat-activated nickel-titanium (HANT) wires), re-stating the overall treatment philosophy. It describes a well-tested and effective system of treatment mechanics for the preadjusted appliance system.

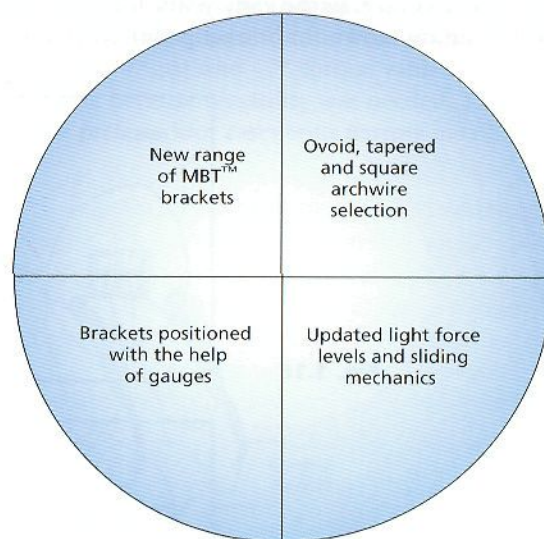


Fig. 1.20 Orthodontic treatment mechanics developed by McLaughlin, Bennett, and Trevisi up to 2001.

OVERVIEW OF THE MBT™ TREATMENT PHILOSOPHY

The following elements make up the MBT™ treatment philosophy, and in the remainder of this chapter each will be reviewed in turn:

- Bracket selection
- Versatility of the bracket system
- Accuracy of bracket positioning
- Light continuous forces
- The .022 versus the .018 slot
- Anchorage control early in treatment
- Group movement
- The use of three arch forms
- One size of rectangular steel wire
- Archwire hooks
- Methods of archwire ligation
- Awareness of tooth size discrepancies
- Persistence in finishing

Bracket selection

At the heart of the technique is a high quality, versatile bracket system. A range of standard metal, mid-sized, and clear brackets is available. The exact bracket specifications are important, and attempts to use 'something similar' can adversely affect the balance of the treatment mechanics, and may not produce the desired treatment result.

The orthodontist's time is the most valuable commodity in the orthodontic clinic. There is a need for the orthodontist to have complete confidence in a reliable bracket system, which gives consistent performance, and can be used to save chairside time in the finishing stages of treatment.

Versatility of the bracket system

The system's full name is MBT™ Versatile+ and as the name implies, it is designed to be versatile, in order to deal with most treatment challenges. This versatility (pp 39–51) is useful in both controlling inventory costs and avoiding needless wire bending.

Accuracy of bracket positioning

This is a cornerstone of the treatment approach. Every effort should be made to ensure accuracy, and it is part of the technique to reposition brackets if necessary as treatment progresses. Gauges and individual bracket-positioning charts are recommended. Interestingly, the search for accuracy has led to an upsurge of renewed interest in indirect bonding (p. 69).

Light continuous forces

The technique requires the use of light continuous forces. The authors believe this is the most effective way to move teeth, being comfortable for the patient and minimizing the threat to anchorage. Light forces are especially important at the start of treatment, when the bracket tip puts demand upon antero-posterior (A/P) anchorage, and when it is important to minimize patient discomfort.

It is not possible to exactly quantify the term 'light forces'. Traditionally, forces in the range below 200 gm were referred to as light forces, and forces in the range above 600 gm were referred to as heavy forces! Essentially there is a need for the orthodontist to use thin, flexible wires early on, with minimal deflection, and to avoid too frequent archwire changes. Also, the clinician needs to recognize the signs of excess force, such as tissue blanching, patient discomfort, and unwanted tooth movements (for example roller coaster effect), and take steps to avoid these.

Later in treatment, during sliding mechanics, light continuous forces are applied using active tiebacks and rigid .019/.025 steel working wires (p. 254). In the finishing stages, light wires such as .014 steel or .016 HANT are used for detailing of tooth positions and settling.

Although 'light forces' cannot be defined or quantified, it is hoped that careful study of this text and the various case reports will give clear clinical guidelines on this subject to the reader.

The .022 versus the .018 slot

The preadjusted appliance seems to perform best in the .022 form. The larger slot allows more freedom of movement for the starting wires, and hence helps to keep forces light (Fig. 1.21). Later in treatment, the steel rectangular working wires of .019/.025 have been found to perform well (Fig. 1.22). With the .018 slot, the main working wire is normally .016/.022 or .017/.025. These wires are more flexible and hence show greater deflection and binding during space closure¹⁴ with sliding mechanics (p. 259).



Fig. 1.21 The .022 slot allows more freedom of movement for the starting arch wires, and this helps to keep forces light.

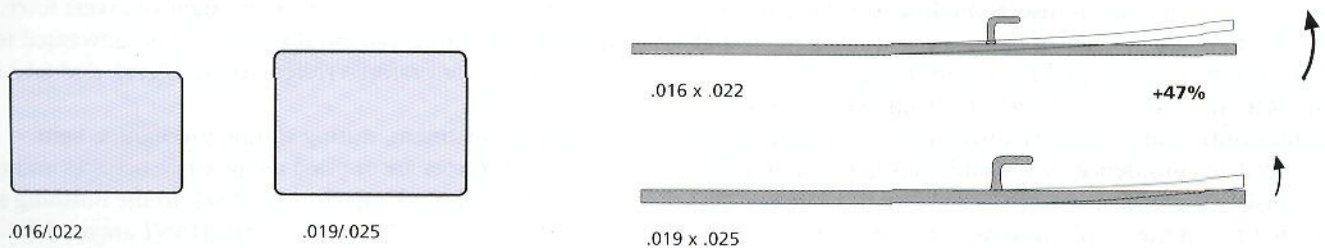


Fig. 1.22 The .019/.025 steel rectangular working wires are more rigid than .016/.022 or .017/.025 wires and perform better during space closure and overbite control.

Anchorage control early in treatment

In the early stages of treatment, the main threat to anchorage comes from the influence of anterior bracket tip. The MBT™ brackets have reduced tip compared with earlier generations of the preadjusted appliance. This, combined with light archwires, results in reduced anchorage needs in the all-important opening stages of treatment. Orthodontists who are new to the treatment approach are often surprised by the reduced demands on anchorage, and gradually find less need for traditional headgear, or palatal and lingual arches.

Lacebacks (Fig. 1.23) are routinely used to assist control of canine crowns in premolar extraction cases, and in some non-extraction cases.

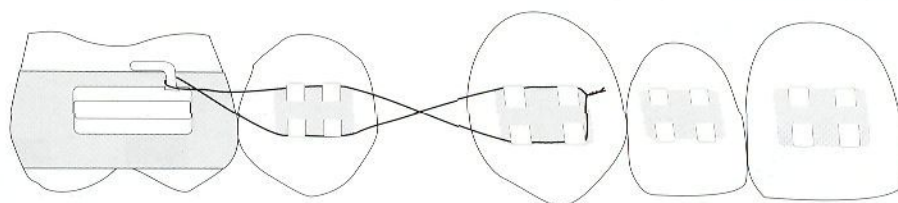


Fig. 1.23 Canine lacebacks are an important feature of the MBT™ treatment philosophy and are used to assist in control of canine crowns during leveling and aligning.

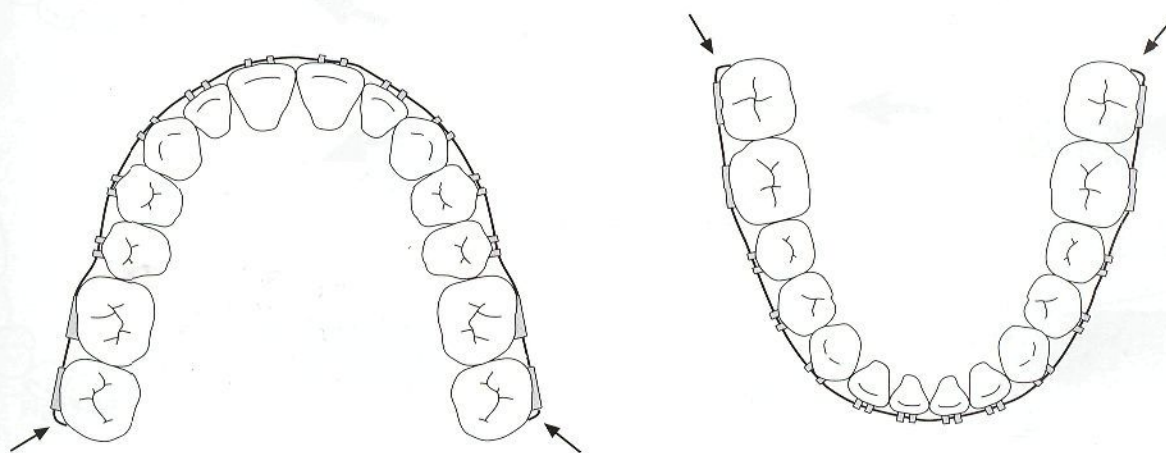


Fig. 1.24 Bendbacks help to prevent mesial movement of the anterior teeth and ensure comfortable positioning of the archwire ends in the molar regions.

Group movement

Where possible, teeth are managed in groups (Fig. 1.25). In preparation for group movement in premolar extraction cases, for example, lacebacks are used to control canines and retract them sufficiently to allow alignment of the incisors. In the lower arch, canines are retracted with lacebacks until anterior crowding is resolved. After this, the lower anterior segment is managed *en masse*, as a group of six or eight teeth. In the upper arch, canines are not normally retracted away from lateral incisors. However, it is important to maintain a Class I canine relationship. Therefore, a laceback should be continued in the upper arch to maintain the Class I canine relationship, even if it means moving the canine away from the lateral incisor (Case JN, p. 123). It is also necessary to move the canine away from the lateral incisor in situations where a lateral incisor is small, and will require future build-up, and in some cases with a midline shift.

The use of three arch forms

Until the mid-1990s the ovoid arch form (p. 76) was preferred for most of the authors' cases. They regarded it as a reliable form for a high percentage of preadjusted appliance cases.

During the late 1990s, the authors found it beneficial to use a tapered arch form for many cases, and sometimes a square arch form. The tapered form has the narrowest inter-canine width and is obviously indicated for patients with narrow, tapered arch forms. The square arch form is indicated in cases with broad arch forms and for cases that require buccal uprighing of the lower posterior segments and expansion of the upper arch. Currently, the recommended technique is to create an individualized form for all patients, based on the ovoid, tapered, or square forms (pp 78–79).

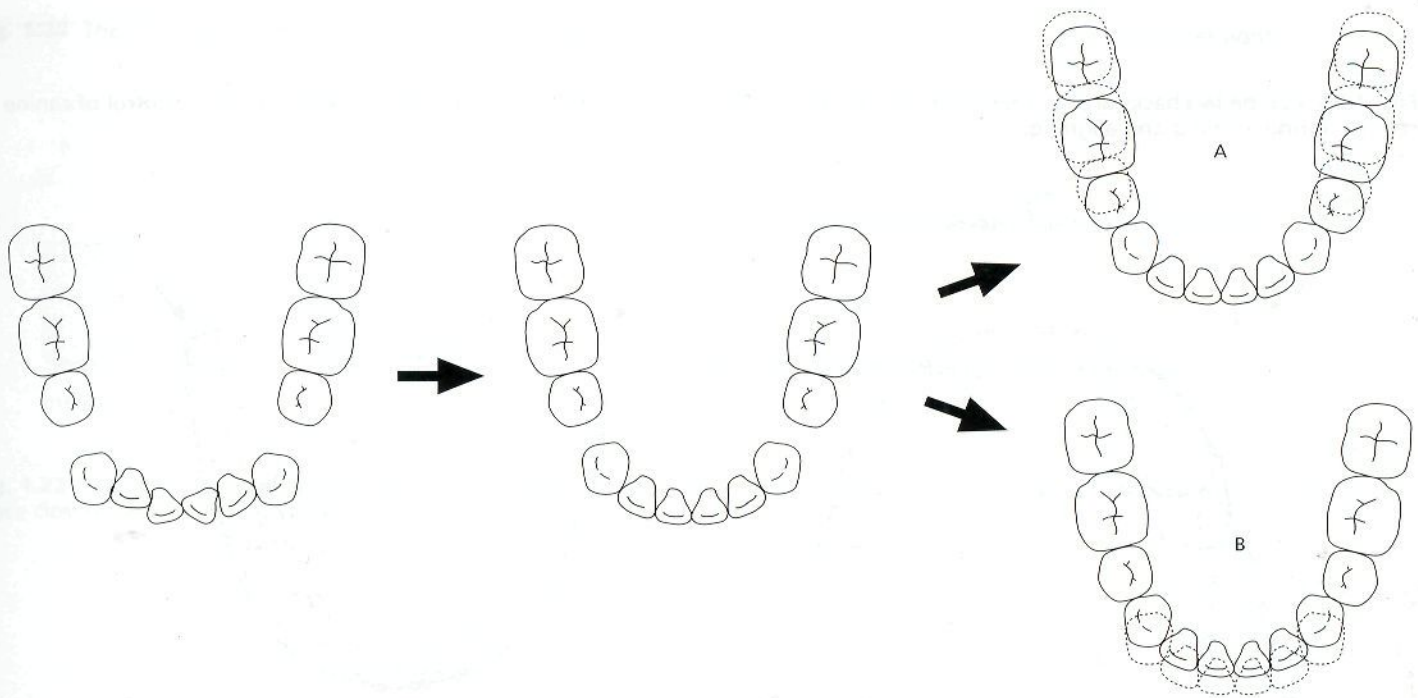


Fig. 1.25 Where possible, group movement is carried out, and the upper and lower anterior segments are managed as a group of six or eight teeth. In situation A, the space has been closed by mesial movement of molars and premolars – a minimum anchorage treatment. In situation B, the incisors and canines have been retracted into the available space – a maximum anchorage situation as might occur in a Class III case or a bimaxillary protrusion case.

One size of rectangular steel wire

Only one size of steel rectangular wire is used in normal treatment, and this is .019/.025. Larger, full thickness steel wires have been evaluated, but although they provide greater control, they are less effective for sliding mechanics. Occasionally .021/.025 wires in steel or HANT may be considered in the later stages of treatment, to obtain full expression of the bracket system. The technique is a 'full arch' approach, and closing loops (p. 252) or sectional wires are seldom used.

Theoretically, there is approximately 10° of 'slop' between the .019/.025 wire and the .022 slot (Fig. 1.26). However, in clinical use the wire performs better than expected, and this is presumed to be due to residual tip which remains uncorrected at the time of placement of the rectangular wire, and persists intermittently during treatment as teeth are moved (Figs 1.26–1.30).

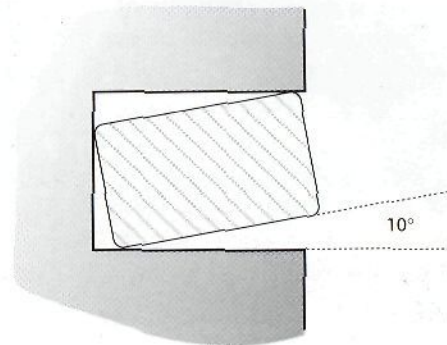


Fig. 1.26

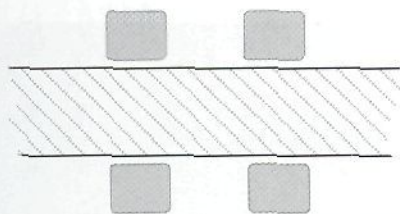


Fig. 1.27

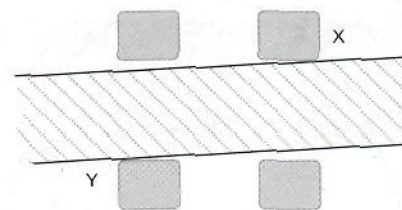


Fig. 1.28

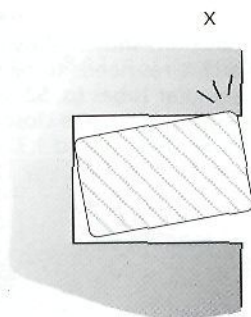


Fig. 1.29

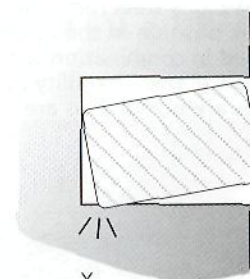


Fig. 1.30

Figs 1.26 to 1.30 The .019/.025 steel rectangular wire performs better than expected. This is presumed to be due to residual tip at the time of placement of the rectangular wire, so that the torquing effect is produced at points X and Y.

Archwire hooks

The working steel .019/.025 rectangular wires normally have soldered hooks, and these are useful for many aspects of treatment mechanics. The average hook positions are 36–38 mm in the upper arch and 26 mm in the lower arch (Fig. 1.31). There is greater variability of hook position in the upper arch, and this is assumed to be due to variation in upper lateral incisor size.

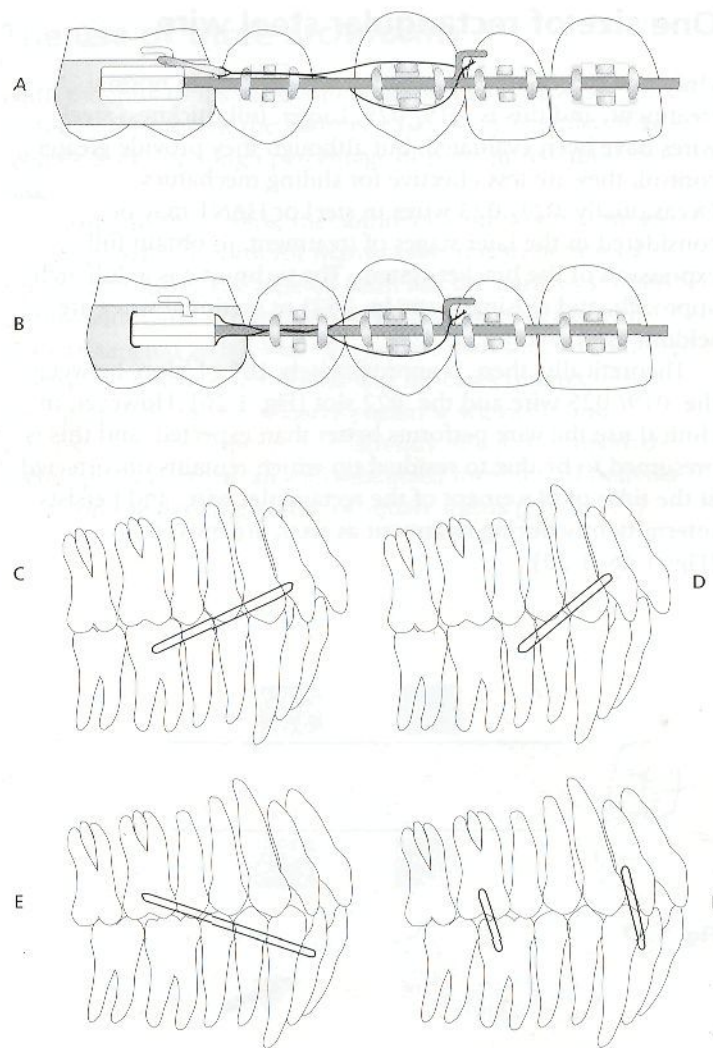
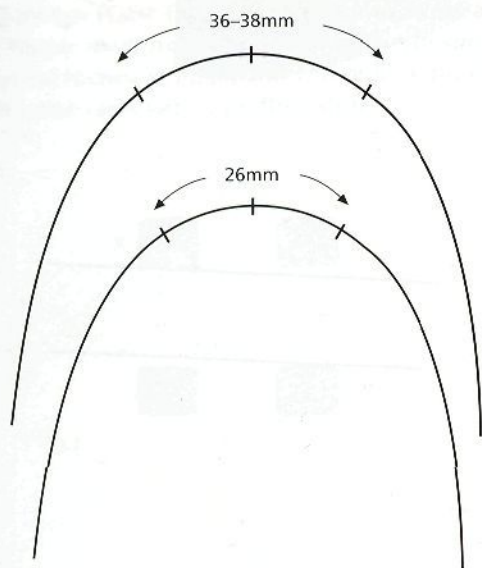


Fig. 1.31 The .019/.025 steel rectangular wires normally have soldered hooks in the positions shown above. There is greater variability of hook position in the upper arch, and therefore a wider range of upper archwires needs to be stocked. The archwire hooks may be used in combination with the hooks on molar tubes or lower second premolar tubes (p. 52) to add versatility to the treatment mechanics. This versatility includes space closure with group movement (A) and tying space closed (B). Long (C) or short (D) Class II elastics are possible, as are Class III (E) and up-and-down elastics (F). See also Figures 1.32 to 1.37 opposite.

The soldered hooks may be used for space closure during sliding mechanics (Fig. 1.32) and for holding space closed (Fig. 1.33).

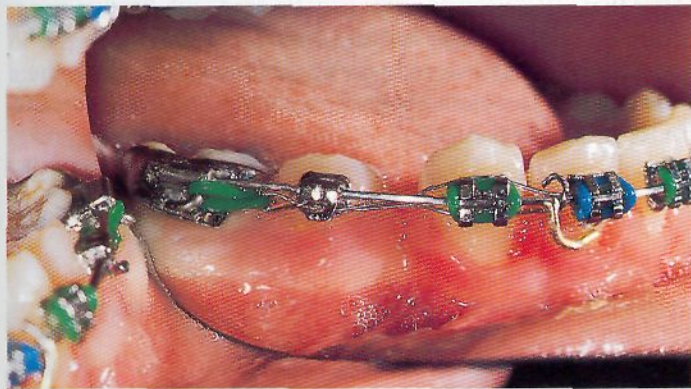


Fig. 1.32 Active tiebacks are applied to the soldered archwire hooks to achieve space closure. Information on tiebacks is available on pages 256 to 258.

They are also used to apply Class II or Class III elastics (Figs 1.34 & 1.35), or for up-and-down elastics (Fig. 1.36), or for short Class II elastics (Fig. 1.37).

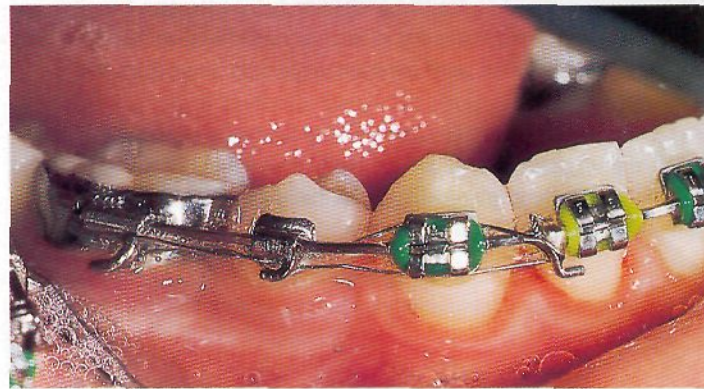


Fig. 1.33 After completion of space closure, passive tiebacks are used to prevent spaces re-opening (Fig. 10.10, p. 286). The second premolar has a bonded tube (p. 52).

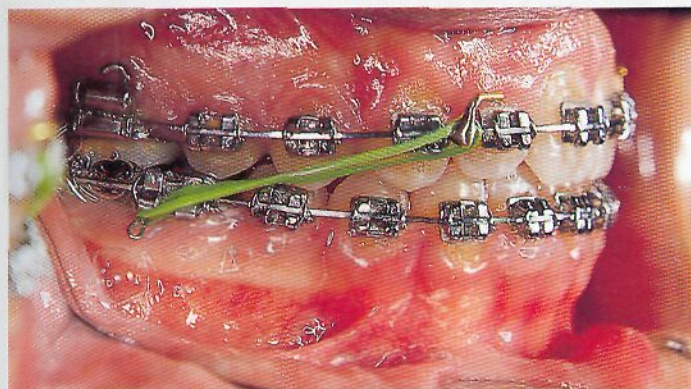


Fig. 1.34 Class II elastics (Fig. 8.12, p. 225) applied to soldered archwire hooks.

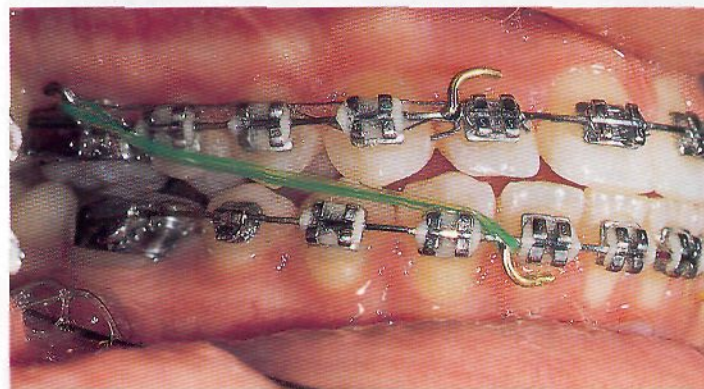


Fig. 1.35 Class III elastics (Fig. 8.11, p. 225).

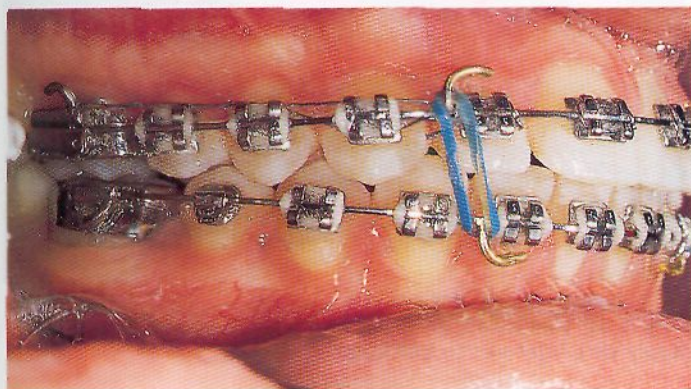


Fig. 1.36 Up and down elastics.

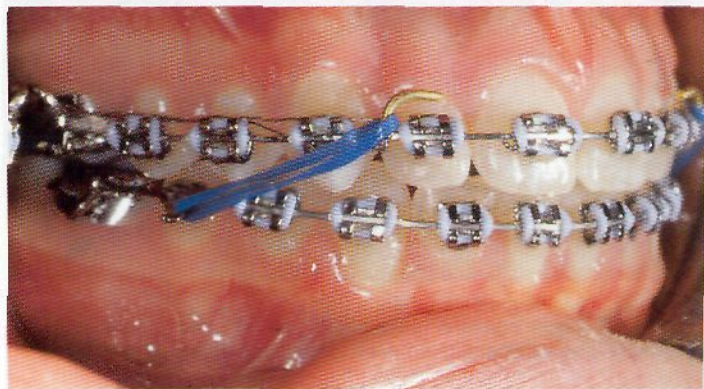


Fig. 1.37 Short Class II elastics from a Kobayashi hook on the lower first premolar.

Methods of archwire ligation

With opening .016 HANT wires the authors favor elastomeric modules (Figs. 1.38 and 1.39) or ligature ties at the first visit, as it is not critical to tie the archwire fully into the bracket slot. At the first adjustment visit it is beneficial to fully tie in any areas where the wire is not completely seated in the bracket slot.

A similar approach is used at the first and second visits with rectangular HANT wires. Any time a HANT wire of any size is not fully engaged it can be helpful to cool the wire locally to assist full engagement.



Fig. 1.38 Conventional elastomeric modules.



Fig. 1.39 'Easy-to-tie' elastomeric modules.

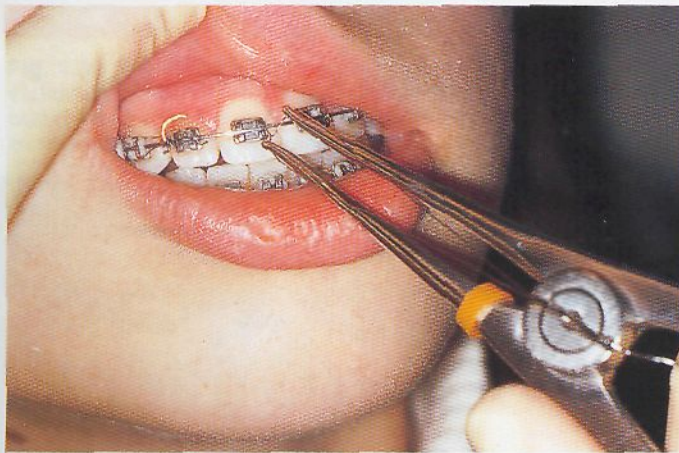


Fig. 1.40 Coon ligature-tying pliers provide more positive archwire engagement than elastomeric modules.

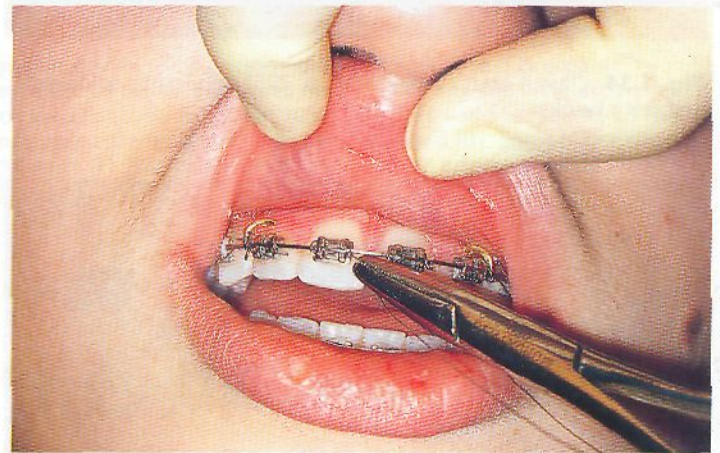


Fig. 1.41 Hemostats or 'mosquito' pliers may also be used to apply wire ligatures to brackets.

Awareness of tooth size discrepancies

It is part of the technique to assess tooth size at the treatment planning stage and throughout treatment. In recent years, much more attention has been paid to tooth size discrepancies, because these can be an obstacle to achieving an ideal result in many cases. For example, it is accepted that enamel reduction among lower incisors is often necessary to obtain good tooth fit in the finishing stages as discussed in Chapter 10.

Persistence in finishing

Finally, in this chapter, it is worth remembering that persistence in finishing is needed, despite all the improvements in bracket design and the better understanding of treatment mechanics.

In the closing stages of treatment, light wires such as .014 steel are used, and archwire bends are frequently required. Also, it is necessary to resist the temptation to remove appliances too early. Time should be spent in finishing and settling using techniques recommended in Chapter 10, and this will be reflected in the final quality of the result.

REFERENCES

- 1 Andrews L F 1972 The six keys to normal occlusion. *American Journal of Orthodontics* 62:296–307
- 2 Reukers E 1997 Straight Wire Appliance versus conventional full edgewise, prospective clinical trial. University of Nijmegen, Nijmegen
- 3 Reukers H A J, Kuijpers-Jagtman A M 1996 Effectiveness of orthodontic treatment: a prospective clinical trial. *European Journal of Orthodontics* 18:424 (abstract)
- 4 McLaughlin R P, Bennett J C 1989 The transition from standard edgewise to preadjusted appliance systems. *Journal of Clinical Orthodontics* 23:142–153
- 5 Bennett J C, McLaughlin R P 1990 Controlled space closure with a preadjusted appliance system. *Journal of Clinical Orthodontics* 24: 251–260
- 6 McLaughlin R P, Bennett J C 1991 Finishing and detailing with a preadjusted appliance system. *Journal of Clinical Orthodontics* 25:251–264
- 7 Bennett J, McLaughlin R P 1993 *Orthodontic treatment mechanics and the preadjusted appliance*. Mosby-Wolfe, London (ISBN 0 7235 1906X)
- 8 Sebata E 1980 An orthodontic study of teeth and dental arch form on the Japanese normal occlusions. *The Shikwa Gakuho* 80(7):945–969
- 9 Watanabe K, Koga M, Yatabe K, Motegi E, Isshiki Y A 1996 A morphometric study on setup models of Japanese malocclusions. *The Shikwa Gakuho*
- 10 Roth R H 1987 The Straight Wire Appliance 17 years later. *Journal of Clinical Orthodontics* 21:632–642
- 11 McLaughlin R P, Bennett J C 1995 Bracket placement with the preadjusted appliance. *Journal of Clinical Orthodontics* 29:302–311
- 12 Bennett J, McLaughlin R P 1997 *Orthodontic management of the dentition with the preadjusted appliance*. Isis Medical Media, Oxford (ISBN 1 899066 91 8). Republished in 2002 by Mosby, Edinburgh (ISBN 07234 32651)
- 13 McLaughlin R P, Bennett J C 1999 Arch form considerations for stability and esthetics. *Revista Espana Ortodontica* 29(2):46–63
- 14 Ouchi K, Koga M, Watanabe K, Issiki Y, Kawada E 2001 The effects of retraction forces applied to the anterior segment on orthodontic arch wires – changes in wire deflection with wire size. Presented to southern California component of Edward H Angle Society. In press.

CASE 55

A short overview of a non-extraction Class I case. Fuller details of treatment mechanics are included in Chapters 4 to 10.

A female patient, aged 10.5 years, with MM angle of 30° and slightly retroclined upper and lower incisors. At the start of treatment, there was mild anterior crowding with some rotations.

During tooth leveling, the MBT™ philosophy involves light forces with appropriate anchorage support from lacebacks or bendbacks. Anchorage support from palatal or lingual bars and/or headgear is used where appropriate. Multistrand or round steel and round or rectangular HANT wires are used. The .022 slot is preferred, and a range of standard metal, mid-sized metal, and clear brackets is available as a coordinated system. Here, accurately positioned mid-sized metal brackets and .016 round HANT wires are in place, with bendbacks. Lacebacks are used mainly in premolar extraction cases, and were not needed in this case. Great importance is given to accuracy of bracket positioning.

The philosophy recognizes three arch forms, and the need for individualization. After tooth leveling and aligning, steel rectangular .019/.025 wires are used to complete arch leveling and overbite control, to correct A/P discrepancies and torque, and to close spaces where necessary. Here, rectangular steel wires with passive tiebacks are in place (Fig 1.47).

Settling techniques are used for one to two months prior to debanding in the majority of cases (Fig 1.48).

The case after 1 month of settling (Fig 1.49).

The case after appliance removal (Fig 1.50).

Lower canine-to-canine bonded retainers are used for most cases, with upper removable retention (see Ch. 11). Post-treatment letters (p. 316) are recommended to encourage good cooperation with the important retention phase.

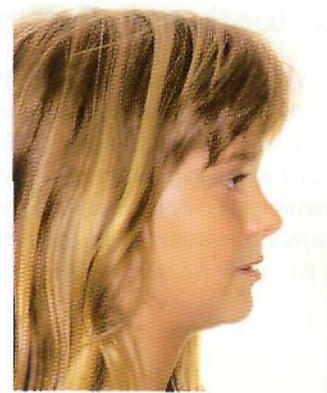


Fig. 1.42



Fig. 1.45



Fig. 1.48



Fig. 1.51



Fig. 1.43

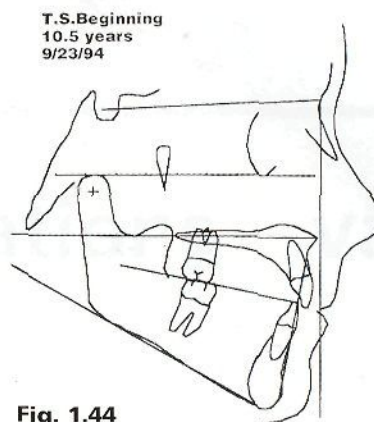


Fig. 1.44

SNA	82°
SNB	79°
ANB	3°
A-N	FH -4 mm
Po-N	FH -13 mm
WITS	0 mm
GoGnSN	33°
FM	30°
MM	30°
1 to A-Po	3 mm
1 to A-Po	0 mm
1 to Max Plane	103°
1 to Mand Plane	80°

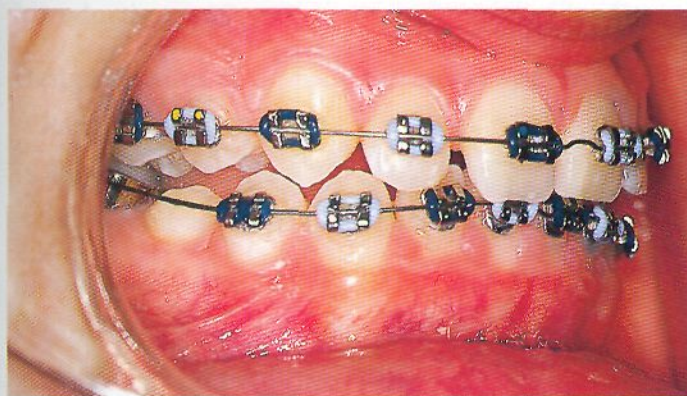


Fig. 1.46



Fig. 1.47



Fig. 1.49

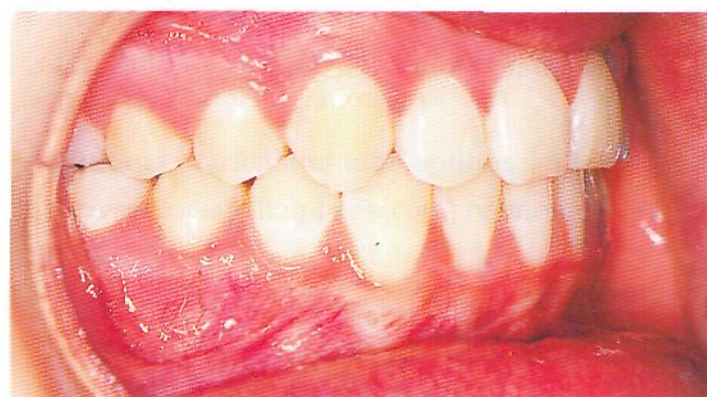


Fig. 1.50



Fig. 1.52

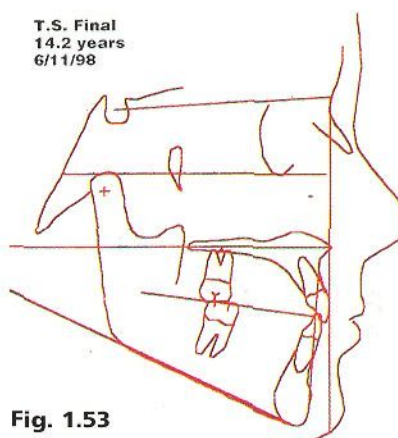


Fig. 1.53

SNA	83°
SNB	82°
ANB	1°
A-N	FH -3 mm
Po-N	FH -7 mm
WITS	-2 mm
GoGnSN	29°
FM	26°
MM	26°
1 to A-Po	3 mm
1 to A-Po	1 mm
1 to Max Plane	109°
1 to Mand Plane	83°

Appliance specifications – variations and versatility

Introduction 27

Design features of a modern bracket system 28

Range of brackets 28

Rhomboidal shape 29

Torque in base – the CAD factor 30

In-out specification 31

Expression of in-out 31

Upper second premolars 31

Tip specification 32

Expression of tip 32

Torque specification 33

Expression of torque 33

Incisor torque 34

Canine torque 36

Upper premolar and molar torque 37

Lower premolar and molar torque 38

The versatility of the bracket system 39

Aspects of versatility 39

Palatally displaced upper lateral incisors 40

Three torque options for the upper canines 44

Three torque options for the lower canines 44

When should the three canine options be used? 44

Interchangeable lower incisor brackets 48

Interchangeable upper premolar brackets 49

Use of upper second molar tubes on first molars in non-HG cases 50

Use of lower second molar tubes on upper molars in Class II molar relationships 51

Additional bracket and tube options 52

Bracket for small upper second premolars 52

Lower second premolar tubes 52

Lower first molar non-convertible tubes 53

Lower first molar double tube and upper first molar triple tube attachments 53

Bondable mini second molar tubes 54

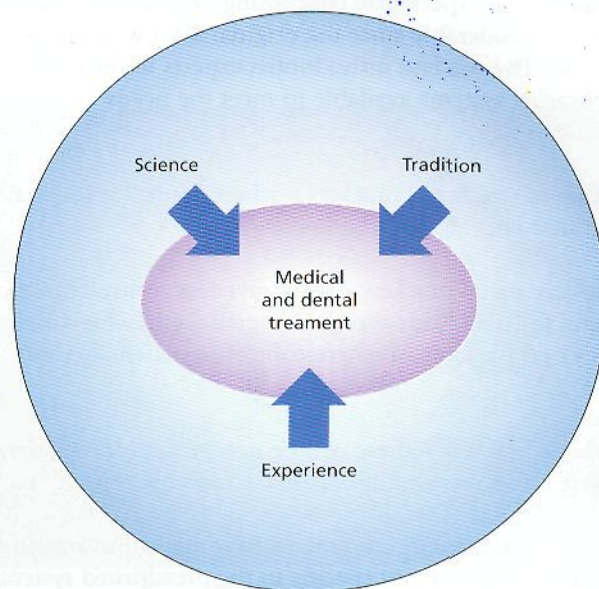
INTRODUCTION

It has been said that medical and dental treatment is based equally on science, tradition, and clinical experience. When the original SWA became available in 1972, it was based on science, but included many of the traditional features of Siamese edgewise brackets. It was radically new and therefore there was no input from clinical experience. Andrews¹ had measured 120 non-orthodontic normal cases and then used the data, with some changes, to produce a bracket system.

It is almost 30 years since the original SWA was released. The science and tradition which went into the original design are now balanced by a wealth of clinical experience. The authors have also re-examined Andrews' original findings, and introduced additional research input from Japanese sources,^{2,3} to update the scientific input.

From an early stage, the authors avoided the traditional heavy edgewise forces and they developed a treatment system based on sliding mechanics and light continuous forces, which has seen widespread acceptance. They developed a third generation of brackets to follow the Andrews (first-generation) and Roth (second-generation) appliances, on the basis that the proven mechanics and force levels should determine the design of the new bracket system, and not vice versa.

The MBT™ Versatile+ bracket system maintains all that was best in the original design, but at the same time a range of improvements and specification changes have been introduced to overcome the clinical shortcomings. It is based on a balanced mix of science, tradition, and experience. The appliance is recommended as a modern version of the preadjusted bracket system for use with light continuous forces, lacebacks, and bendbacks. It was designed to work ideally with sliding mechanics.



www.allislam.net
Problem

DESIGN FEATURES OF A MODERN BRACKET SYSTEM

Range of brackets

The baseline of expectation concerning orthodontic brackets has risen considerably since the original SWA was released in the 1970s. The modern orthodontist expects to have three main bracket systems available to meet the needs of a typical caseload:

- Standard size metal brackets – where control is the main requirement (Fig. 2.1).
- Mid-size metal brackets – these give less control, but are useful for cases with average to small teeth, where there is poor oral hygiene, or where control needs are modest (Fig. 2.2).
- Esthetic brackets – these will be needed for older patients, where a metal appearance is not acceptable (Fig. 2.3).

These are general developments in orthodontic bracket technology. They are not specific to the preadjusted system, but they are changes which were incorporated into the new concept.

The original i.d. system of dots and dashes has been superseded by laser numbering of standard size metal brackets (Figs 2.1, 2.4 & 2.5). This feature cannot be carried through into mid-size brackets, owing to their smaller size, and it is technically not possible with clear brackets. So for these groups of brackets, a more conventional i.d. system of colored dots continues to be used.

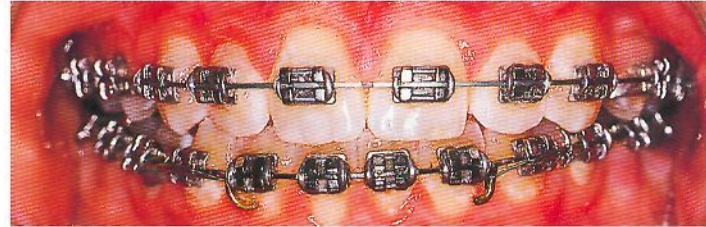


Fig. 2.1 Standard size metal brackets.

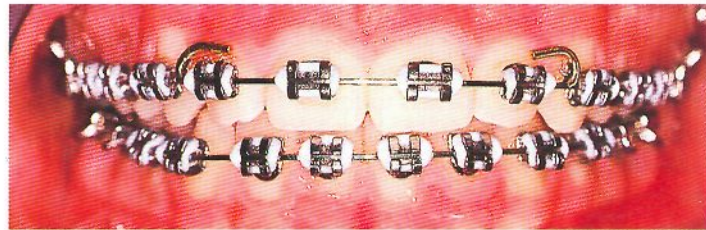


Fig. 2.2 Mid-size metal brackets.

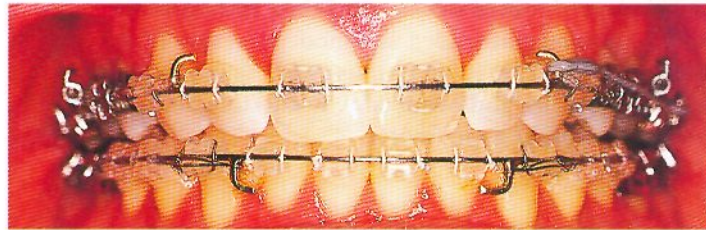


Fig. 2.3 Esthetic Clarity™ brackets.

Rhomboidal shape

The original rectangular shape of the standard metal SWA (Fig. 2.4) has been superseded by the rhomboidal form (Fig. 2.5).

This reduces the bulk of each bracket and allows reference lines in both the horizontal and the vertical planes, thereby assisting accuracy of bracket placement.

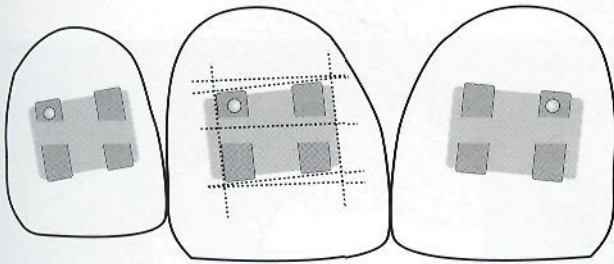


Fig. 2.4 The original standard metal SWA brackets were rectangular in shape, and the i.d. system was based on dots in the upper arch and dashes in the lower arch.

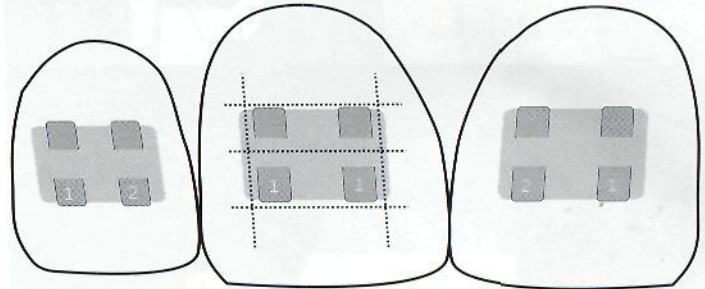


Fig. 2.5 Brackets of a rhomboidal shape have reduced bulk and there is coordination of perspective lines through only two planes, which assists in accuracy of bracket placement.

Torque in base – the computer-aided design (CAD) factor

Torque-in-base was an important issue with the first- and second-generation preadjusted brackets, because level slot line-up was not possible with brackets designed with torque-in-face. Technology was not available to set bracket slots in the correct position relative to the facial surfaces of the crowns without torque-in-base. Modern bracket systems, including the MBT™ system, have been developed using computer-aided design and computer-aided machining – the CAD-CAM system. This allows more flexibility of design, not only to place the slots in the correct position in the brackets, but also to enhance bracket strength and features such as depth of tie wing and labio-lingual profile. The computer is first able to locate the precise location for the bracket slot, relative to in-out distance and torque position for each tooth. Once this position is established, it can then build up the 'in-fill' areas to optimize all requirements of the brackets (Figs 2.6–2.8).

The brackets may be finished with all torque-in-base (full size and clear) or with a combination of torque-in-base and torque-in-face (mid-size) with absolutely no difference in slot position. Since the advent of CAD-CAM bracket design, it is not necessary to discuss this historical issue any longer!

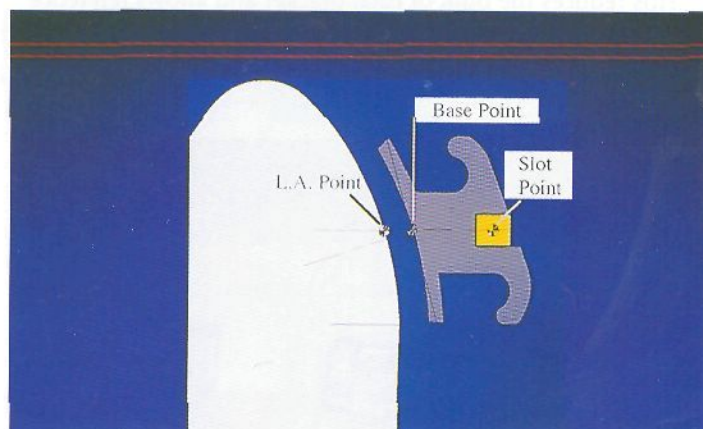


Fig 2.6 Brackets with torque in base were designed so that the LA point, the base point, and the slot point were on the same horizontal plane. To accomplish this an acute ($<90^\circ$) angle was required at the occlusal aspect of the bracket base, and an obtuse ($>90^\circ$) angle at the gingival aspect of the bracket base.

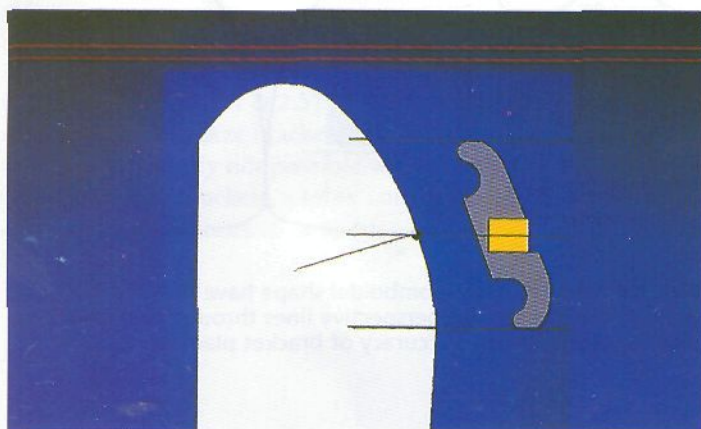


Fig 2.7 The CAD system analyzes the ideal slot location and then designs the in-fill of the bracket as necessary.

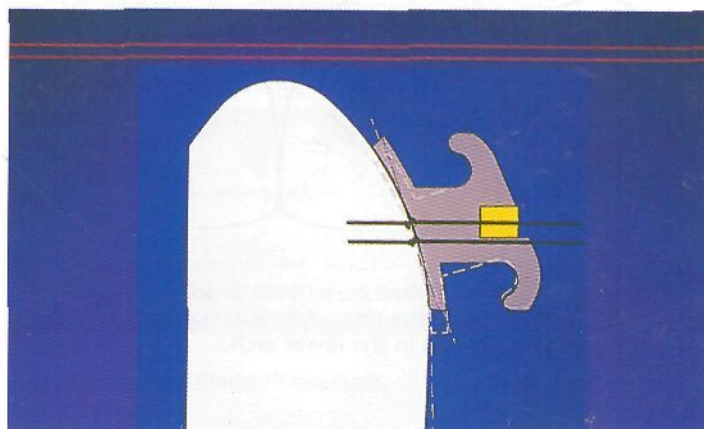


Fig 2.8 The outcome of the CAD process is that the resulting bracket can have torque in base, torque in face, or a combination of the two.

IN-OUT SPECIFICATION

Expression of in-out

The in-out feature of preadjusted brackets is 100% fully expressed, because the archwire lies snugly in the slot. The labio-lingual movement is rapid, and normally occurs in one visit. The original SWA in-out specification was therefore used as a basis when designing the MBT™ system.

Upper second premolars

Andrews' 120 research normals all had teeth with full-size crowns in the labio-lingual dimension, but in clinical practice upper second premolars have small crowns in approximately 20% of cases. An alternative bracket, which is 0.5mm thicker than normal, is useful for such teeth (Figs 2.9–2.11). This feature is helpful in obtaining good alignment of marginal ridges in cases with small upper second premolars and is discussed on page 52. For cases with upper first and second premolars of the same size, the upper first premolar bracket is used for both teeth. Only a small inventory of upper second premolar brackets is required, and this should be monitored by one staff member.

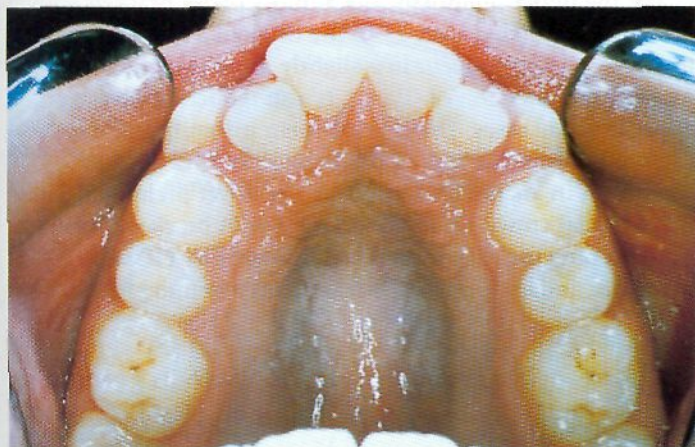


Fig. 2.9 This case has small upper second premolars.

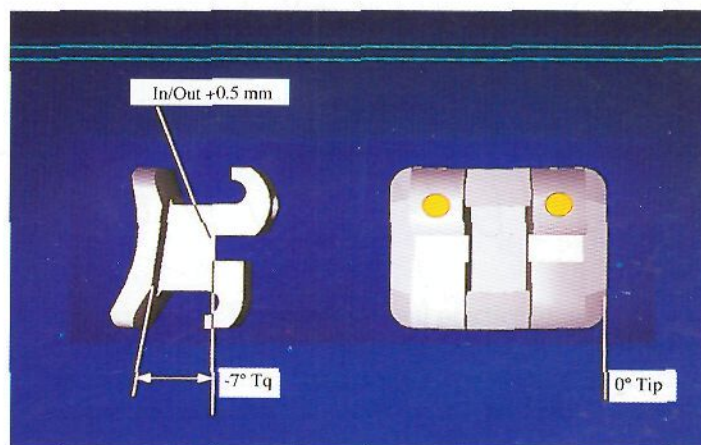


Fig. 2.10 A premolar bracket which is 0.5mm thicker than normal is useful for small upper second premolars.

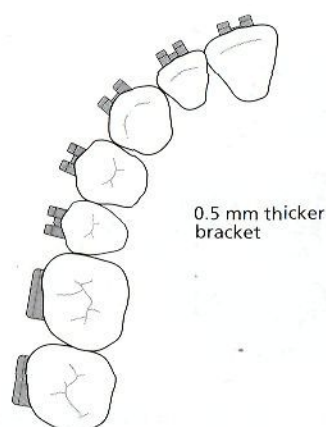
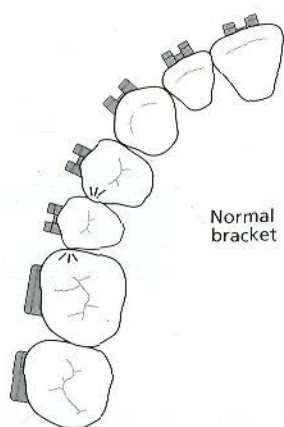


Fig. 2.11 Approximately 20% of cases have upper second premolars with small clinical crowns, and a bracket which is 0.5mm thicker is helpful in obtaining good alignment of marginal ridges without wire bending for these cases.

TIP SPECIFICATION

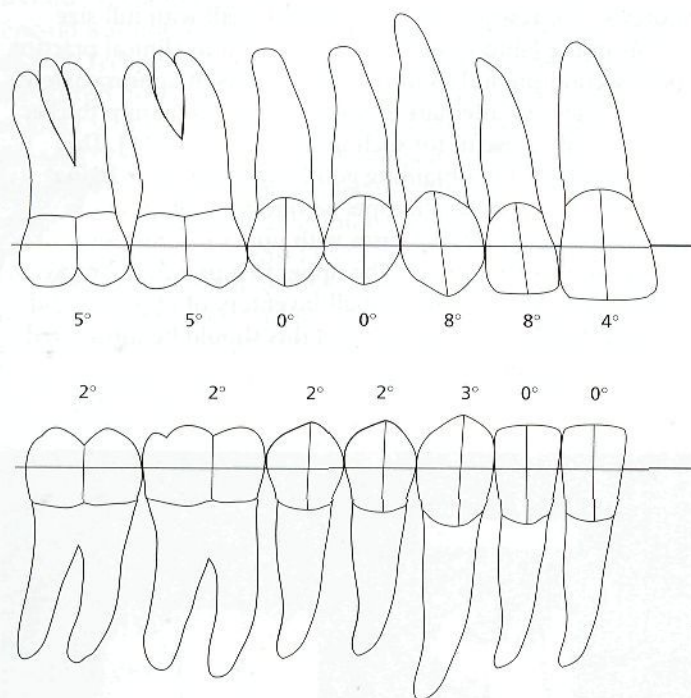


Fig. 2.12 Recommended tip.

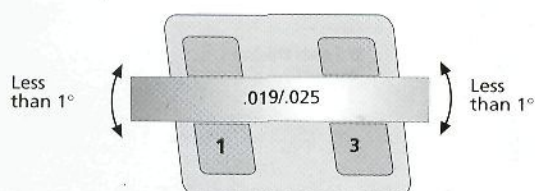


Fig. 2.13 The tip feature of preadjusted brackets is almost fully expressed, and there is less than 1° of 'slop' when a .019 / .025 rectangular wire is placed.

Expression of tip

The tip feature of preadjusted brackets is almost fully expressed. A .019/.025 wire in an upper canine bracket with 8° of built-in tip will express most of that tip. More than 7° of the 8° will be fully expressed (Fig. 2.13). With light continuous force mechanics, tip can be well controlled, and tip specifications are fully and rapidly expressed in clinical use. The research figures for tip were closely adhered to when the MBT™ bracket system was designed, although small changes were made to the tip specification for molar and upper premolar attachments.

For all molars, a 0° tip bracket is recommended. If placed parallel to the buccal cusps of the molars, a 0° tip bracket will deliver 5° of tip for the uppers and 2° of tip for the lowers (Fig. 2.14). This issue has been discussed at length elsewhere, and the reader is referred to other texts for more detailed information.⁴

For the upper premolars, the authors prefer brackets with 0° of tip, compared with 2° in the original SWA. This places the crowns of these teeth in a slightly more upright position, more in the direction of Class I. It also reduces anchorage needs in some cases. The 2° may seem insignificant, but the total of 8° from the four upper premolars does become significant in anchorage terms. For the lower premolars, the 2° of mesial crown tip in the original SWA brackets works well, keeping the crowns inclined forwards in a Class I direction, and continues to be used and recommended.

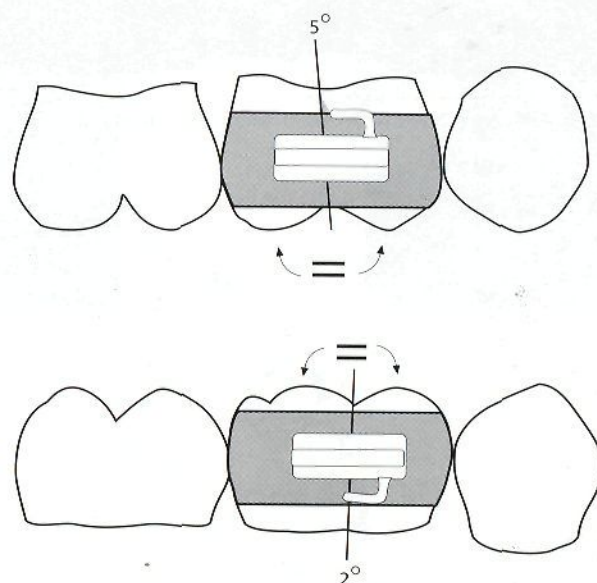


Fig. 2.14 Upper and lower molar attachments have 0° tip. When placed parallel to the buccal cusps of the molars, this delivers 5° of tip in the uppers and 2° of tip in the lowers.

TORQUE SPECIFICATION

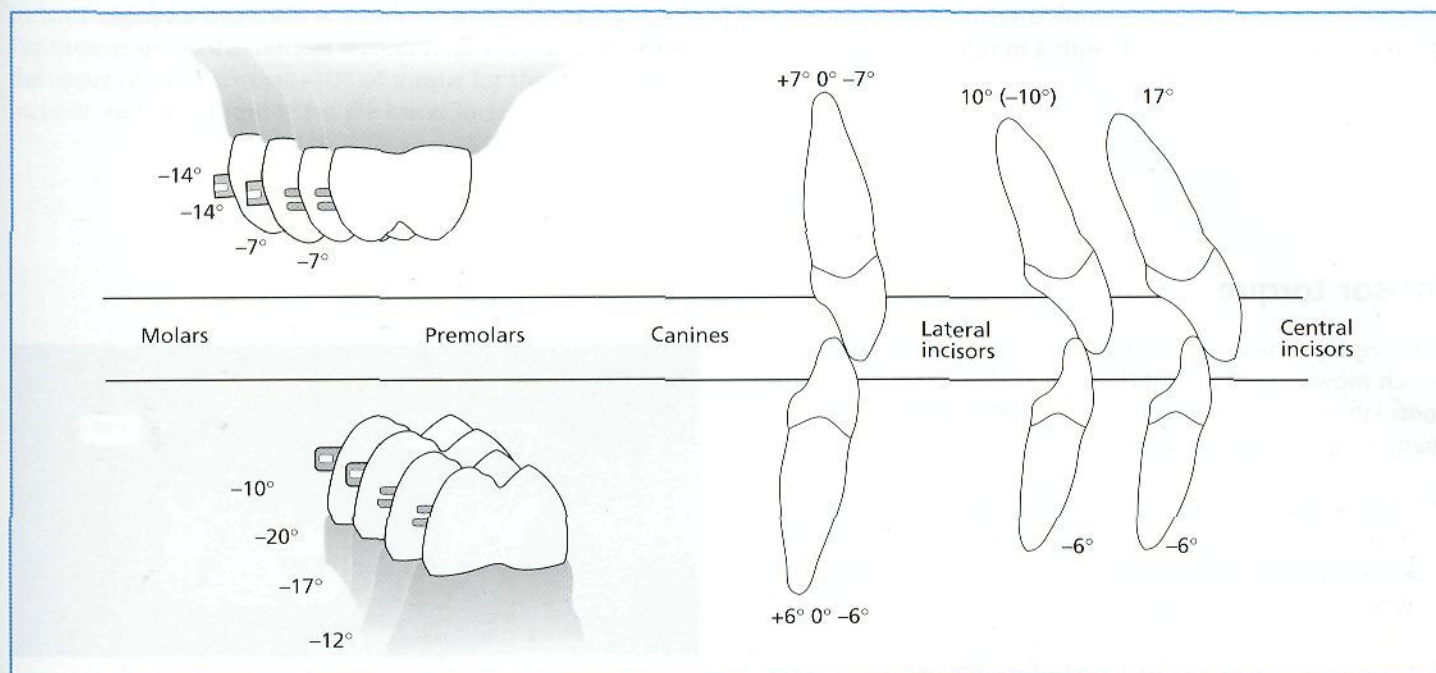


Fig. 2.15 Recommended torque specifications

Expression of torque

As discussed above, in-out and tip features are efficiently expressed by the preadjusted appliance system. In contrast, torque is not efficiently expressed, owing to two mechanical reasons:

- The area of torque application is small, and depends on the twist effect of a relatively small wire, compared with the bulk of the tooth (Fig. 2.16).

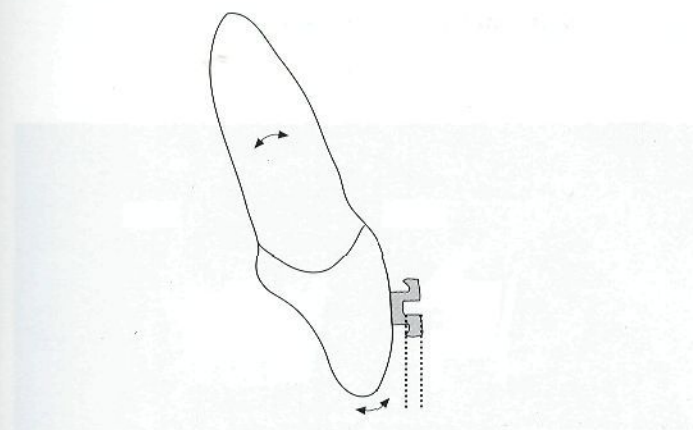


Fig. 2.16 Torque is not efficiently expressed by the preadjusted appliance system, partly due to the small area of torque application.

- In order to slide teeth, it is normal practice to use .019/.025 steel wires in a .022 slot, because a full-thickness wire prevents sliding. These wires have 'slop' of about 10°, depending on the tolerances in bracket and wire manufacturing, and the amount of wire edge 'rounding' or 'radiusing' (Fig. 2.17).

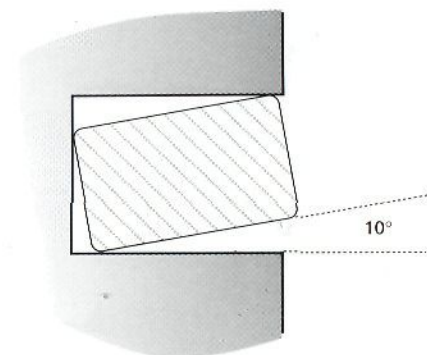


Fig. 2.17 A rectangular .019/.025 steel wire in .022 slot will have approximately 10° of 'slop'. The exact amount depends on the precision of manufacture of the wire and bracket slot and the amount of wire edge 'rounding' or 'radiusing'.

As a result of the relative inefficiency of preadjusted brackets in delivering torque, it was necessary to build extra torque into the incisor, molar, and lower premolar brackets, in order to meet clinical goals with a minimum of wire

Incisor torque

It is helpful clinically to have torque control (Figs 2.18–2.21) which moves upper incisor roots palatally and lower incisor roots labially. This treatment requirement is necessary for many types of malocclusion:

- Class II cases, where Class II elastics can cause torque to be 'lost' on the upper incisors, and where lower incisors tend to procline during leveling and in response to Class II elastics.
- Class I cases, where correct incisor torque helps to achieve good anterior tooth fit.
- Class III cases, where correct torque can help to compensate for mild Class III dental bases.

bending. Arch form factors, together with canine prominence and other issues, made it necessary to have brackets with three options for canine torque, as discussed on pages 44 to 48.

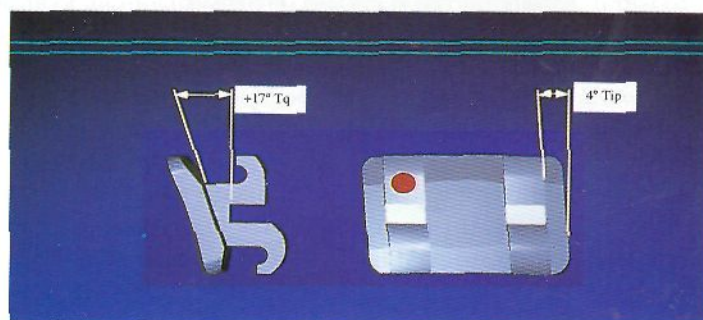


Fig. 2.18 Upper central incisor bracket.

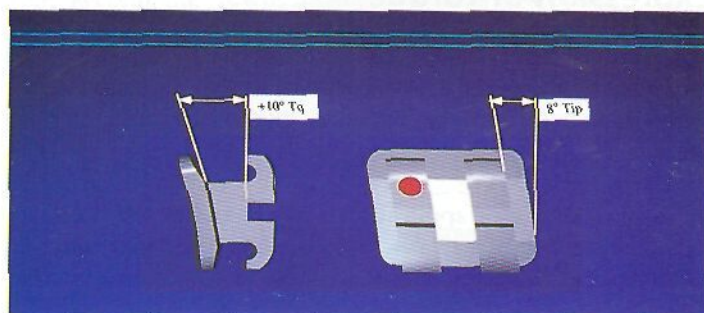


Fig. 2.19 Upper lateral incisor bracket.

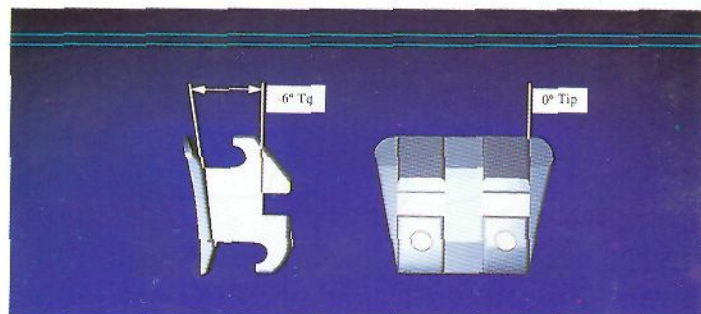


Fig. 2.20 Lower incisor bracket.

Because of these frequent clinical requirements, there is generally a need for greater palatal root torque of the upper incisors and for more labial root torque of the lower incisors. For these reasons, the authors recommend $+17^\circ$ of torque for the upper central incisors, $+10^\circ$ of torque for the upper lateral incisors, and -6° of torque for the lower incisors (Fig. 2.21).

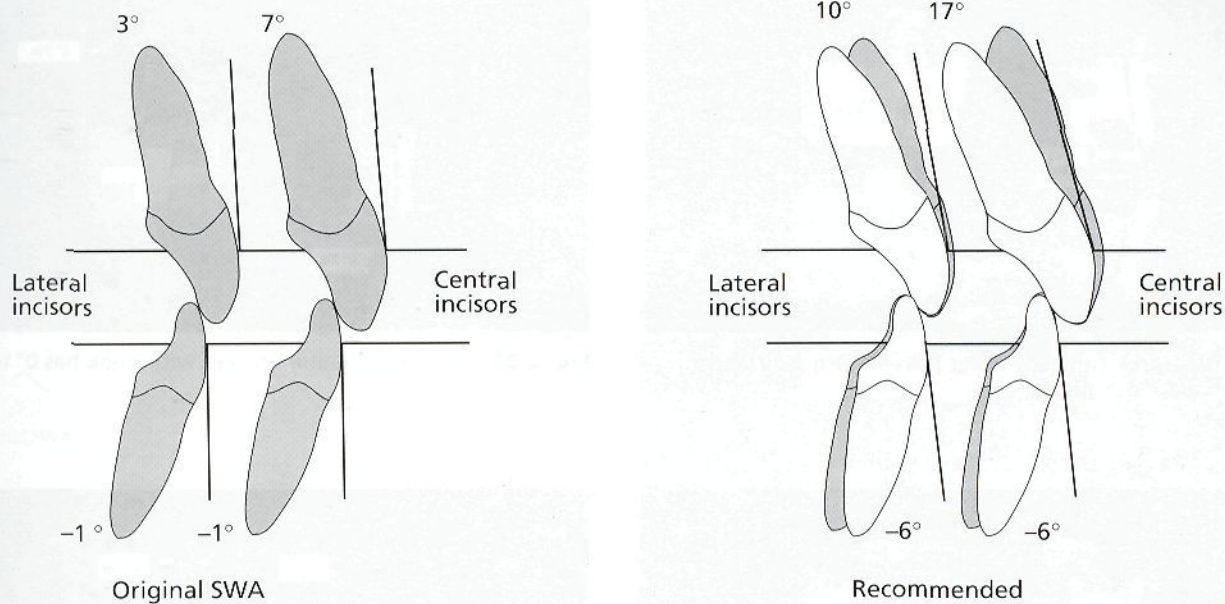


Fig. 2.21 The authors recommend $+17^\circ$ of torque for the upper central incisor, $+10^\circ$ of torque for the upper lateral incisors, and -6° of torque for the lower incisors to assist in movement of upper incisor roots palatally and lower incisor roots labially.

Canine torque

Andrews' 120 non-orthodontic normals were non-extraction adults. However, a typical orthodontic caseload is a different sample. The finding of -7° torque for the upper canines has proved to be satisfactory for most cases, but the original SWA value of -11° torque for the lower canines has not been satisfactory, as it tends to leave the lower canine roots in a

prominent position in most cases. Versatility is needed for canine torque values. A range of -7° , 0° and $+7^\circ$ torque is therefore available for the upper canines (Figs 2.22 & 2.23) and -6° , 0° , and $+6^\circ$ for lower canines (Figs 2.24 & 2.25), as described on pages 44 and 45.

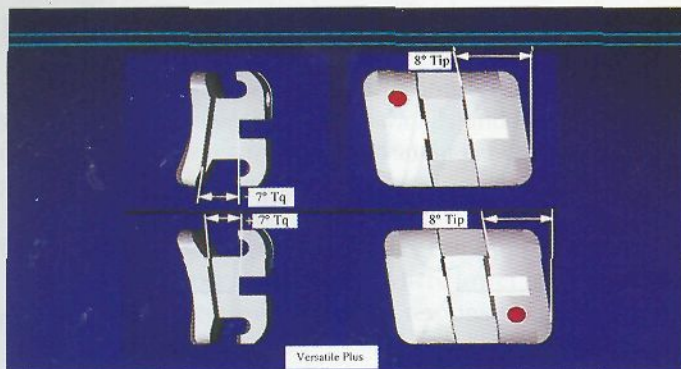


Fig. 2.22 The upper canine bracket has -7° torque. When inverted it has $+7^\circ$ torque.

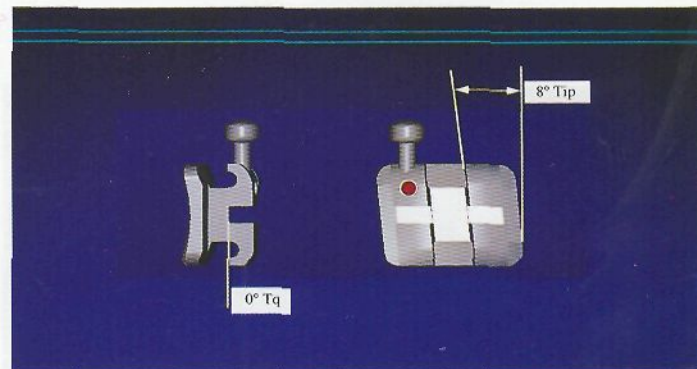


Fig. 2.23 The upper canine bracket with hook has 0° torque.

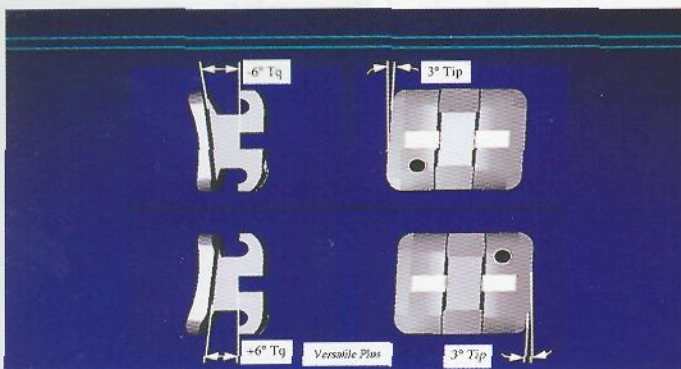


Fig. 2.24 The lower canine bracket has -6° torque. When inverted it has $+6^\circ$ torque.

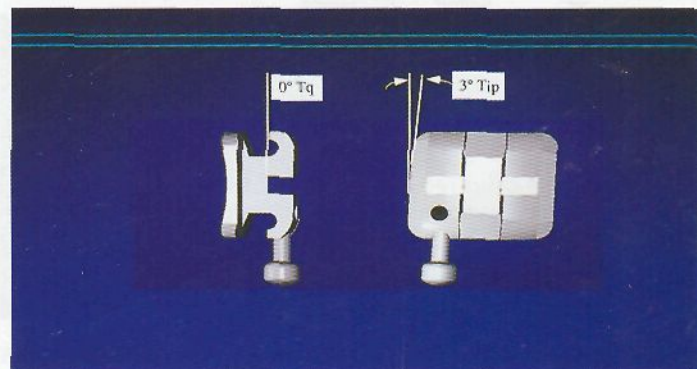


Fig. 2.25 The lower canine bracket with hook has 0° torque.

Upper premolar and molar torque

The upper premolar torque value of -7° has proven to be satisfactory in clinical use, and the authors continue to work with it.

For upper molars, on the other hand, the -9° of the original SWA has proven to be inadequate, and they prefer -14° , as this gives better control of the palatal cusps (Fig. 2.26). The -14° specification for the upper molars helps to reduce interferences during function, by preventing the palatal cusps from hanging down. It is important to have a sufficiently wide maxilla to allow this torque change. If not, cortical plate interference prevents achievement of correct torque.

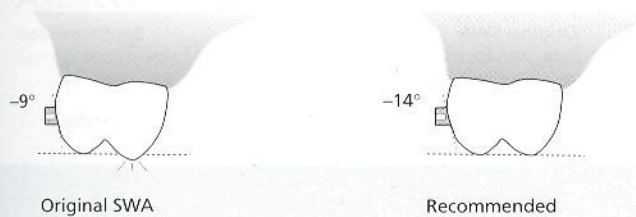


Fig. 2.26 Upper molar attachments with -14° of torque give better control of the palatal cusps.

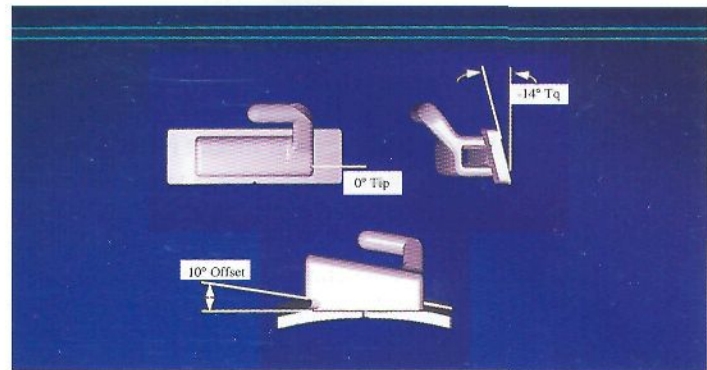


Fig. 2.27 Upper second molar tube.

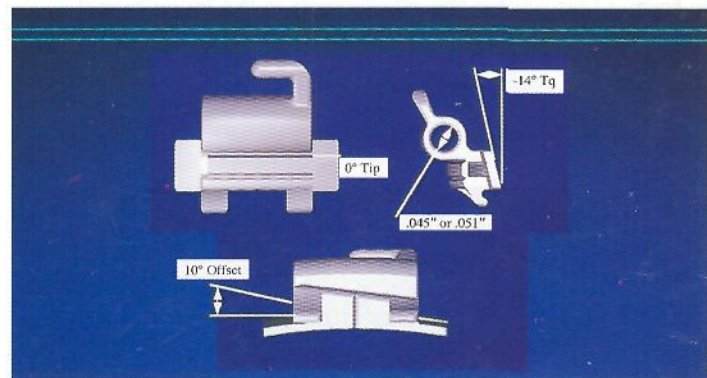


Fig. 2.28 Upper first molar tube.

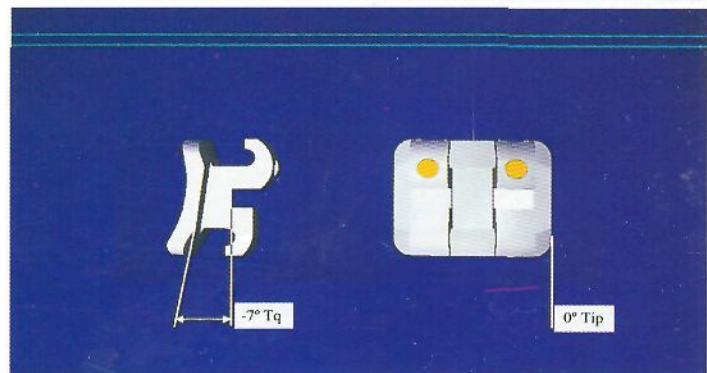


Fig. 2.29 Upper first and second premolar bracket.

Lower premolar and molar torque

Many orthodontic cases have narrow maxillary arches, with the lower arches showing a compensating narrowing. These cases normally require buccal crown torque (uprighting) of the lower molars and premolars. Also, the original SWA first molar torque (-30°) and second molar torque (-35°)

Fig. 2.30 The authors have recommended substantial changes in torque features for the attachments in the lower buccal segments, compared with the original SWA. This reduces the 'rolling-in' of lower molars as well as assisting in the development of the mandibular arch.

specifications allowed 'rolling-in' of lower molars. Therefore the authors have made the important decision to change lower premolar torque by 5° , first molar torque by 10° , and second molar torque by 25° (Fig. 2.30).

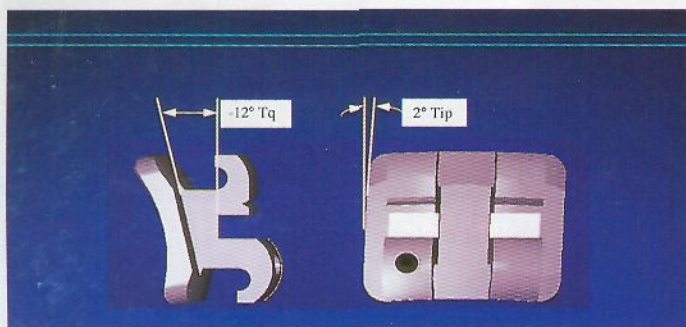
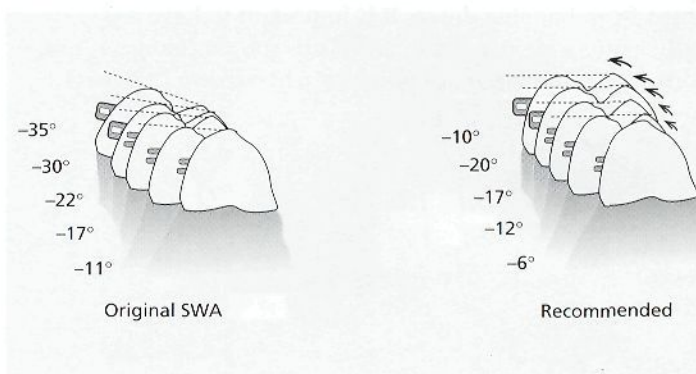


Fig. 2.31 Lower first premolar bracket.

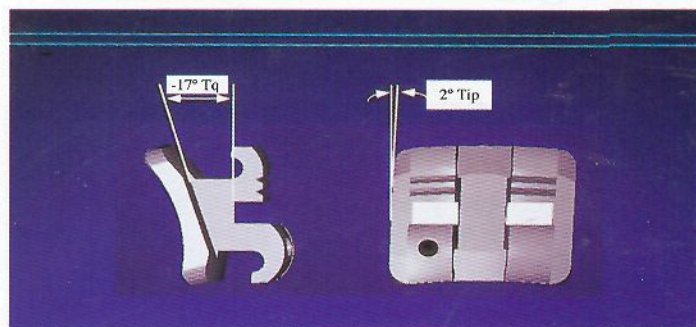


Fig. 2.32 Lower second premolar bracket.

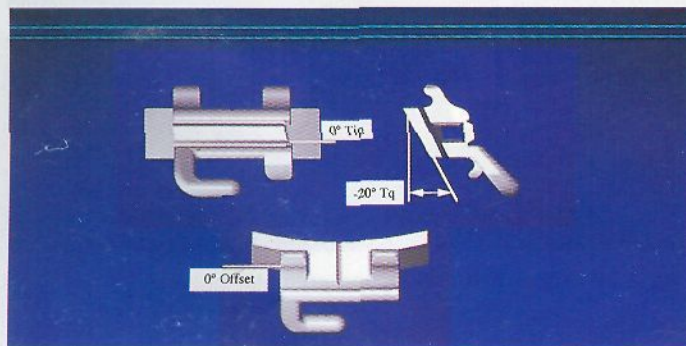


Fig. 2.33 Lower first molar convertible buccal tube.

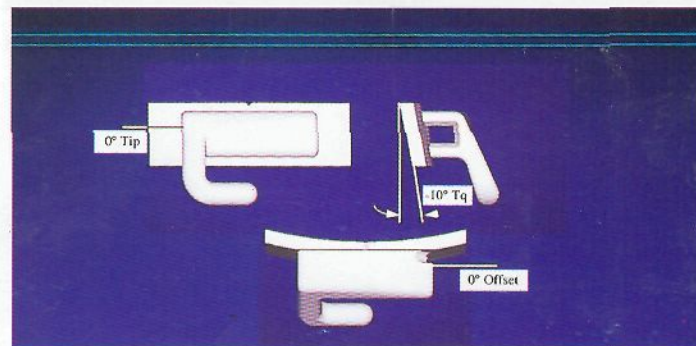


Fig. 2.34 Lower second molar tube.

THE VERSATILITY OF THE BRACKET SYSTEM

The first and second generation (p. 6) of brackets and buccal tubes had a single option for each specific tooth, with a recommendation for proper tip, torque and in-out compensation. There was little room for versatility. The MBT™ Versatile+ bracket system has overall design improvements compared with previous appliances. These include changes in tip and torque, as well as design features which introduce a new characteristic for the preadjusted system – that of versatility.

As described below, the innovation incorporates seven different bracket and buccal tube possibilities, depending on the needs of the case. This creates a platform for the archwires and the bracket system to produce the necessary individualization and overcorrection for certain types of case. The benefit can apply to individual teeth or to groups of teeth, in some instances. This reduces the need for first-, second- and third-order bends later in treatment, and improves efficiency.

Aspects of versatility

Seven main areas of versatility are listed below, and they will be reviewed in turn:

1. Options for palatally displaced upper lateral incisors (-10°).
2. Three torque options for the upper canines (-7° , 0° , and $+7^\circ$).
3. Three torque options for lower canines (-6° , 0° , and $+6^\circ$).
4. Interchangeable lower incisor brackets – the same tip and torque.
5. Interchangeable upper premolar brackets – the same tip and torque.
6. Use of upper second molar tubes on first molars in non-HG cases.
7. Use of lower second molar tubes for the upper first and second molars of the opposite side, when finishing cases to a Class II molar relationship.

Palatally displaced upper lateral incisors

The orthodontist is often called upon to correct upper lateral incisors which are palatally displaced. Cases with upper anterior crowding on Class I or Class III dental bases are liable to have upper lateral incisors which are in crossbite, and it can be difficult to achieve stable root correction. There is a risk of moving the crown labially, while leaving the root palatally placed. In this situation, there will be a need for additional wire bending, and treatment time will be extended.

A convenient way to manage these cases involves the following procedures:

- During the alignment stage, it is necessary to create enough space for the palatally displaced tooth. This is achieved using coil spring. The brackets on the adjacent teeth are tied with wire ligatures, to prevent rotations (Figs 2.35 & 2.36).

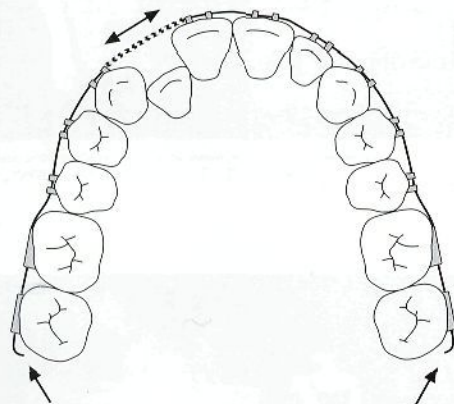
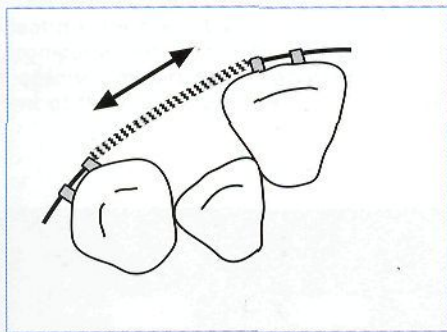


Fig. 2.35 It is necessary to create sufficient space for palatally displaced incisors before attempting to move them labially. Bendbacks are placed 2 mm distal to molar tubes, to allow an increase in arch length.

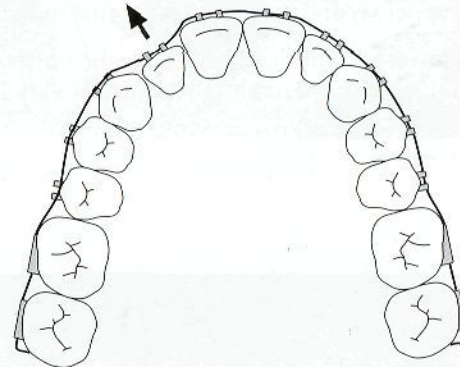
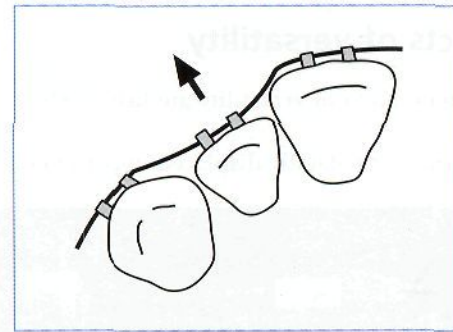
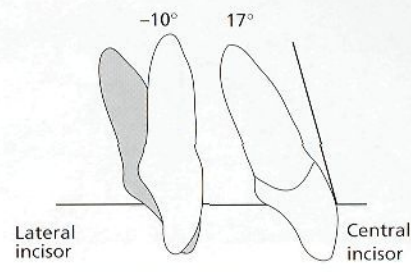
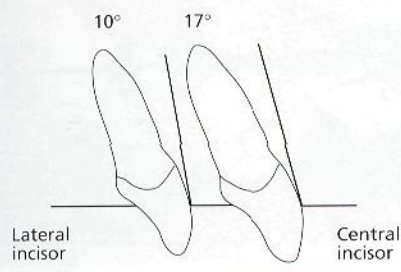


Fig. 2.36 After creation of space, a .015 multistrand wire or a .016 HANT wire may be used to gently move the lateral incisors labially.

- The palatally displaced lateral incisor is bracketed with the normal bracket, but it is rotated 180° (Figs 2.37 & 2.38), which changes the torque from +10° to -10°. This assists in labial root torque at the rectangular wire stage. The tip stays the same at 8°. The left side bracket is placed on the

left incisor and the right side bracket is placed on the right incisor. This is mentioned because it is a frequently asked question! It is not correct to place the left incisor bracket on the right incisor or vice versa.



Rotated 180°

Fig. 2.37 Conventional placement of an upper lateral incisor bracket gives +10° of torque.

Fig. 2.38 Rotation of the lateral incisor bracket by 180° changes the torque from +10° to -10°.

In the following treatment sequence, the use of coil spring is shown, as a method of re-creating space to allow alignment of a palatally displaced upper lateral incisor. The coil spring was re-activated by using a split round tube (517-620 3M Unitek).

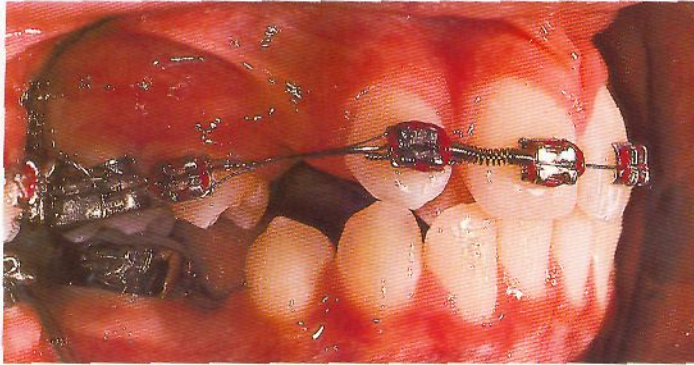


Fig. 2.39A A decision was made to extract upper first premolars and lower second premolars in this crowded Class I case with a palatally displaced upper right lateral incisor and an upper midline shift to the right. After initial leveling and aligning, a coil spring was placed to create space for the lateral incisor. The lower arch brackets were not placed at this stage, because a lower acrylic splint was likely to be needed later in the treatment.



Fig. 2.39B The case 1 month after Figure 2.39A. Space-opening procedures of this type should be carried out on .018 round steel wires or heavier wires. A section of closed coil spring is being used with the center part stretched to activate. By using closed coil spring in this way, there is normally not a problem with sharp ends, as can happen with open coil spring. Modules have been removed ready for adjustment and reactivation.

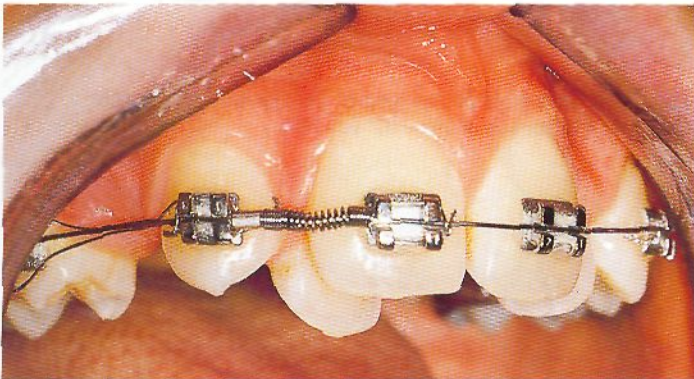


Fig. 2.39C Here a split round tube has been placed onto the archwire to reactivate the coil spring. It is therefore not necessary to remove the archwire to reactivate. Teeth adjacent to the coil spring always need to be tied with wire ligatures, to prevent unwanted rotations.

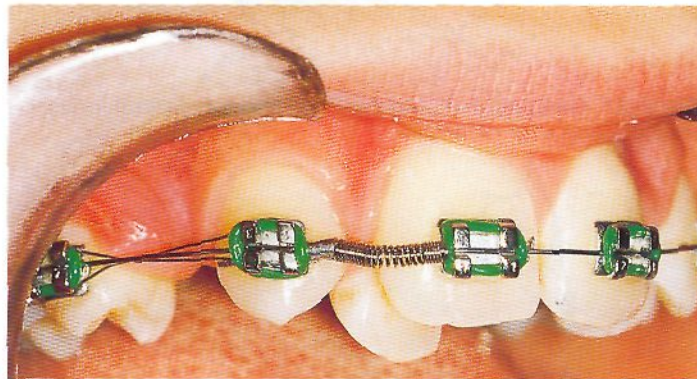


Fig. 2.39D Modules have been placed, and the patient will be seen again in 4 weeks. The coil spring will re-create space for the lateral incisor and help to restore the midlines.

In the following treatment sequence, the correction of a palatally displaced upper lateral incisor is shown.



Fig. 2.40A This non-extraction case presented with an upper left lateral incisor in crossbite.

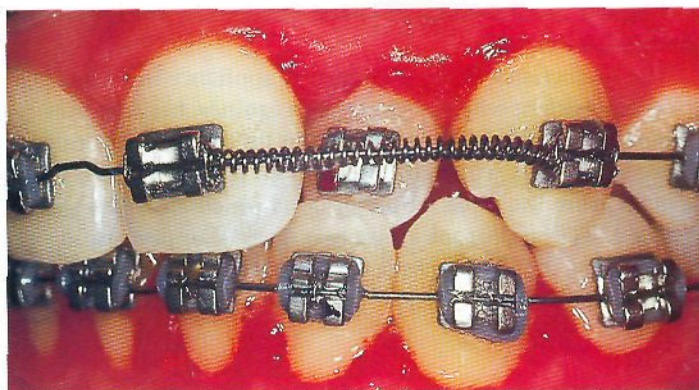


Fig. 2.40B Open coil spring is being used to create space for the lateral incisor (p. 40) before an attempt is made to move it labially. Teeth adjacent to the coil spring are tied with wire. The upper left lateral incisor bracket is rotated 180°.

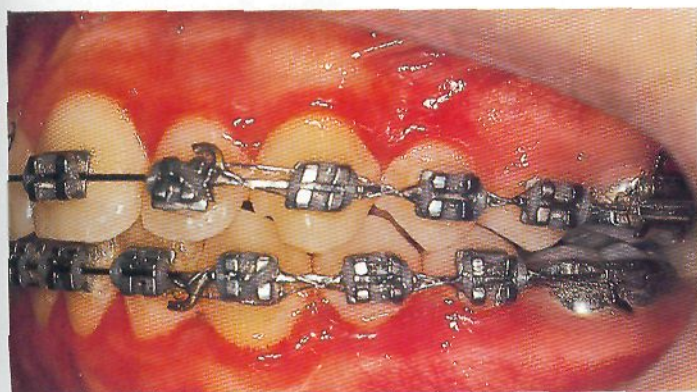


Fig. 2.40C Rectangular steel .019/.025 working wires are in place. No additional wire bending was required in this case.

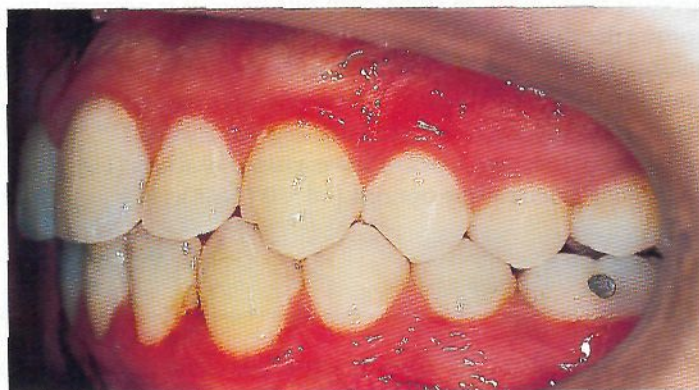


Fig. 2.40D The case after appliance removal.

Three torque options for the upper canines (-7° , 0° , $+7^\circ$)

Effective torque control of the upper canines is necessary, because they are key elements in a mutually protected occlusion. The goal is to deliver ideal tip and torque to the canines, so that they can fulfil their role in lateral excursions, and have a small amount of lateral freedom in maximum inter-cuspation.

The inefficiency of the preadjusted appliance in delivering torque is evident when working with canines, because they are the teeth with the longest roots in the human dentition. There will be less wire bending required if a correct selection is made from the three torque options which are available.

The MBT™ philosophy uses two types of upper cuspid bracket (Fig. 2.41) to provide three possible torque options (-7° , 0° , $+7^\circ$).

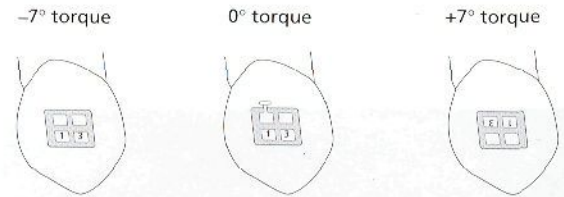


Fig. 2.41 The MBT™ philosophy has three torque options for the upper arch.

Three torque options for the lower canines (-6° , 0° , $+6^\circ$)

The original SWA value of -11° torque⁴ was not satisfactory, as it tended to leave the lower canine roots too prominent in some cases. The authors prefer -6° lower canine torque, but for some cases they may use 0° or even $+6^\circ$. They favor reduced lower canine torque, compared with the research findings, because lower canine roots sometimes show gingival recession, and benefit from being moved into alveolar bone. Also, in some deep bite cases, it is necessary to torque the canine crown labially and at the same time maintain the canine root in alveolar bone. The -6° figure coordinates well with the 5° torque changes made to the specification in the lower premolar region. The MBT™ philosophy uses two types of lower cuspid brackets (Fig. 2.42) to provide three torque options (-6° , 0° , $+6^\circ$).

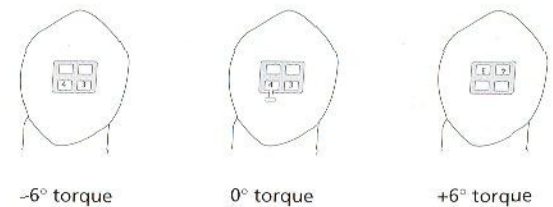


Fig. 2.42 The MBT™ philosophy has three canine torque possibilities for the lower arch.

www.allislam.net
Problem

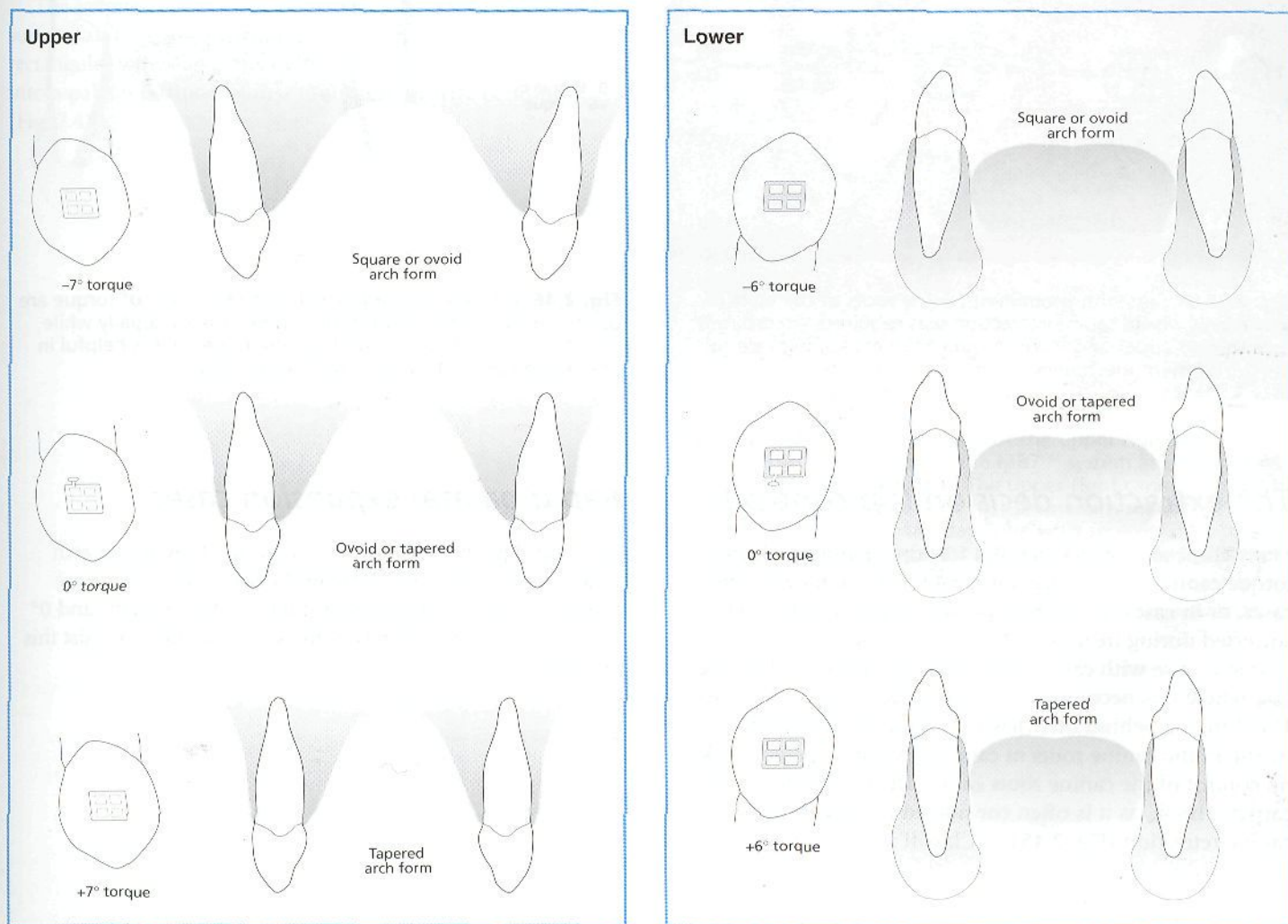
When should the three canine options be used?

There are six main factors which govern selection of canine brackets:

1. Arch form
2. Canine prominence
3. The extraction decision (tip control)
4. Overbite
5. Rapid palatal expansion
6. Agenesis of upper lateral incisors, where space is to be closed.

Arch form

If the patient has well-developed arches, and if substantial tooth movements are not required, then -7° upper and -6° lower canine brackets are normally chosen. A more ovoid or tapered arch form may suggest the use of 0° torque brackets for upper and lower canines. If the patient clearly has a narrow tapered arch form (Case AL, p. 86), then $+7^\circ$ upper and $+6^\circ$ lower brackets will be beneficial in many cases (Figs 2.43 & 2.44).



Figs 2.43 and 2.44 Arch form is an important factor in selection of canine brackets in upper and lower arches.

Canine prominence

The -7° upper and -6° lower torque canine brackets are normally not correct if the patient has prominent canines, or canine gingival recession, at the start of treatment. Brackets with 0° torque or $+7^\circ$ upper and $+6^\circ$ lower torque should be selected (Fig. 2.45).

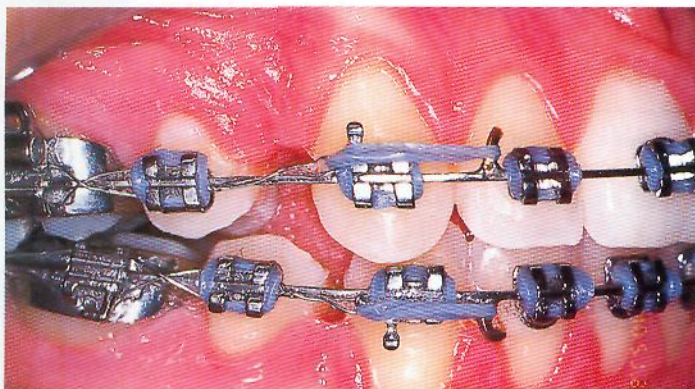


Fig. 2.45 A case with prominent canine roots at the start of treatment, where canine retraction was required. Accordingly, zero torque upper and lower canine brackets are in place to assist treatment mechanics.

The extraction decision (tip control)

Many clinicians believe that the -7° upper and -6° lower torque canine brackets are not ideal for premolar extraction cases, or in cases where there is considerable canine tip to be corrected during treatment. They prefer brackets with 0° torque for use with canine retraction mechanics and in any case where it is necessary to substantially change canine tip. The thinking behind this view is that the 0° brackets tend to maintain the canine roots in cancellous bone, thereby making tip control of the canine roots easier. The 0° canine bracket carries a hook, as it is often considered for cases which require canine retraction (Fig. 2.45) or Class II mechanics.

Overbite

In Class II/2 cases and other deep bite situations there is often a requirement to move the lower canine crowns labially, but to maintain the roots centered in the bone. This is more easily achieved if 0° or $+6^\circ$ lower canine brackets are selected (Fig. 2.46).

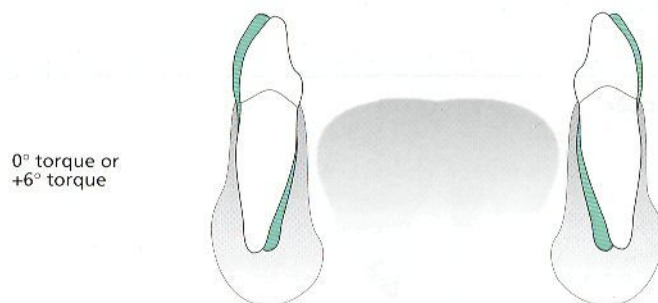


Fig. 2.46 If lower canine brackets with 0° or $+6^\circ$ of torque are used, this facilitates moving the canine crowns labially while maintaining the roots centered in the bone. This is helpful in managing deep bite situations in some cases.

Rapid palatal expansion cases

After rapid palatal expansion, widening of the upper arch creates a secondary widening in the lower arch. There are torque changes (uprighting) among the lower teeth⁵ and 0° or $+6^\circ$ lower canine brackets are recommended to assist this favorable change.

Agenesis of upper lateral incisors, where space is to be closed

If one or both upper lateral incisors are missing, a decision may be made to close the spaces, and bring the canines mesially into contact with the central incisors. In this situation, it is helpful to invert the -7° upper canine bracket 180° . This changes the torque to $+7^\circ$, but the tip stays the same at 8° . The left side bracket is placed on the left canine and the right side bracket is placed on the right canine. It is not correct to place the left canine bracket on the right canine or vice versa.

The inverted canine bracket is well adapted to the tooth surface, and the in-out dimension will be correct. At the rectangular wire stage, this helps to torque the canine root into a palatal position with a minimum of wire bending (Fig. 2.47).

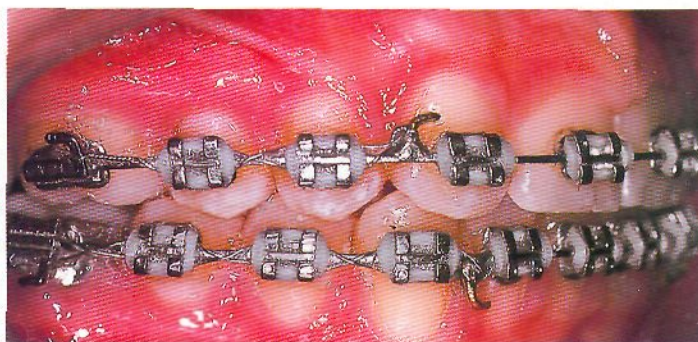
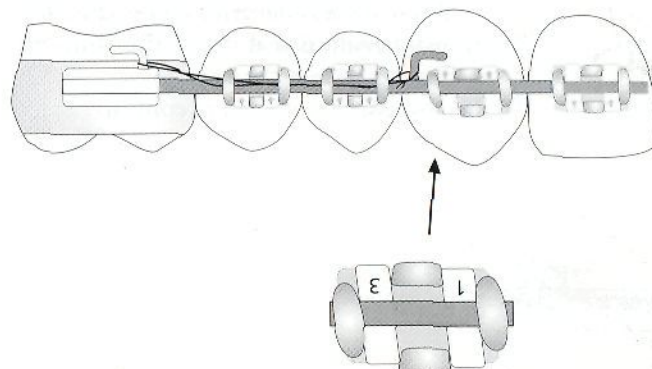


Fig. 2.47 This case had agenesis of the upper right lateral incisor. Versatility features of the MBT™ system are being used to assist treatment mechanics. The upper right canine bracket is inverted 180° . The upper right first permanent molar carries a lower left second molar bonded tube with zero rotation to assist in achieving a good Class II molar relationship at the end of treatment (Fig. 2.58, p. 51).

Interchangeable lower incisor brackets

For the lower incisor brackets, 0° tip was used to reflect the research findings, and to make less demand on lower arch anchorage. An additional benefit is that the 0° tip allows all the lower incisor brackets to be interchangeable (Figs 2.48–2.50), thereby assisting inventory control.

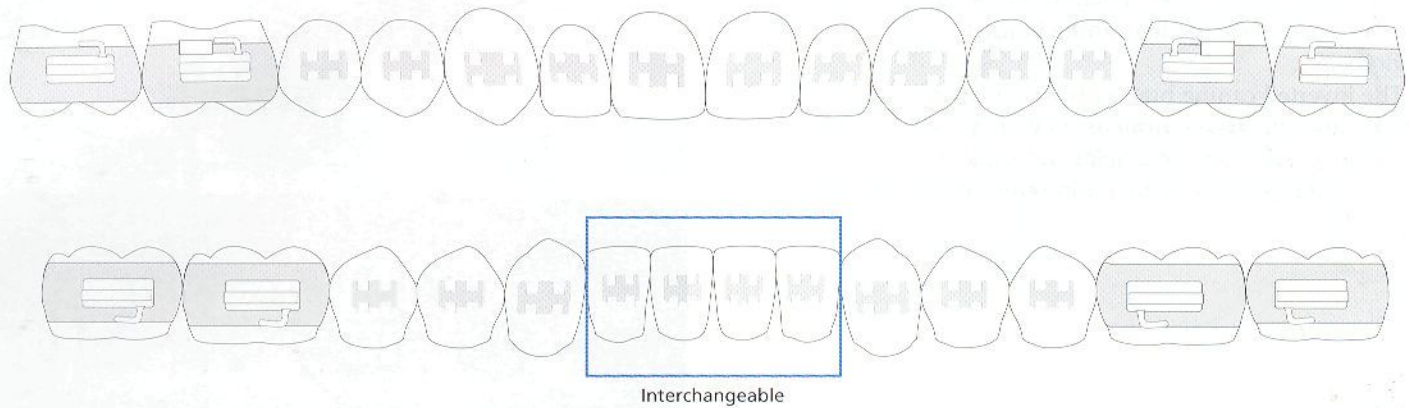


Fig. 2.48 The 0° tip feature of the lower incisor brackets allows them to be interchangeable.



Fig. 2.49 Lower incisor brackets have zero tip, and are interchangeable.

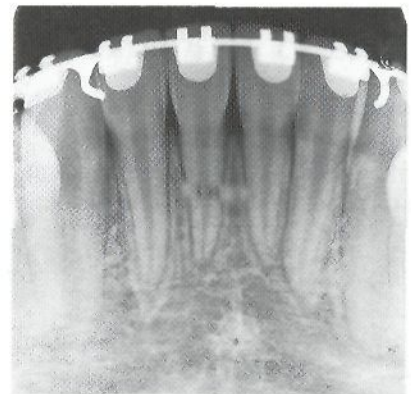


Fig. 2.50 Intra-oral radiographs showing parallel lower incisor roots in the case featured in the adjacent photograph.

Interchangeable upper premolar brackets

Similar comments can be made concerning the upper premolar brackets. The bracket system was designed with 0° tip for all the upper premolars, to make less demand on

anchorage, and to assist in achieving a Class I relationship. The 0° tip allows them to be interchangeable (Figs 2.51–2.54), which helps inventory control.

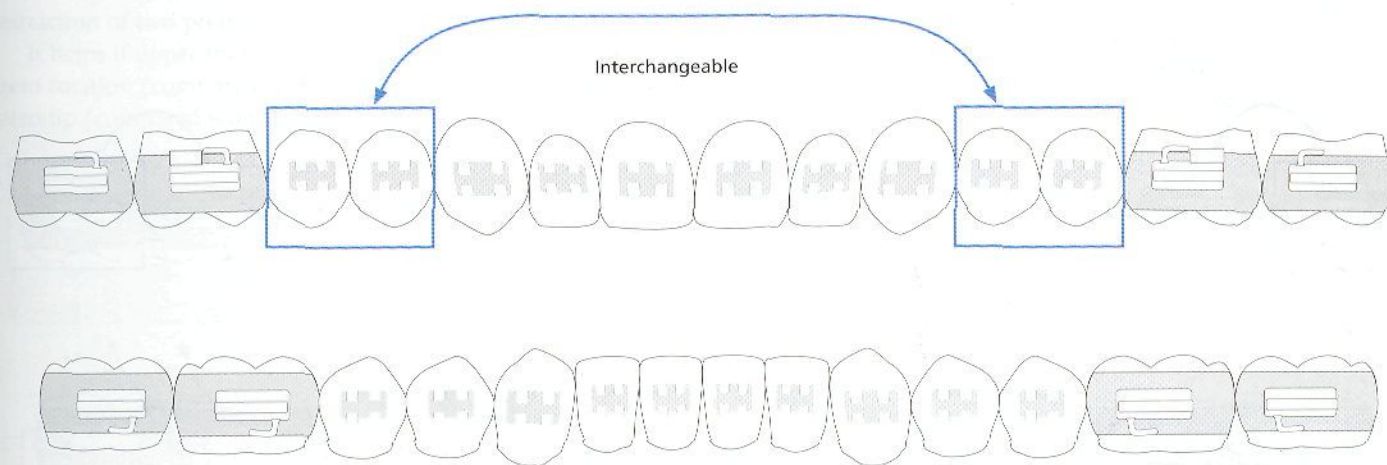
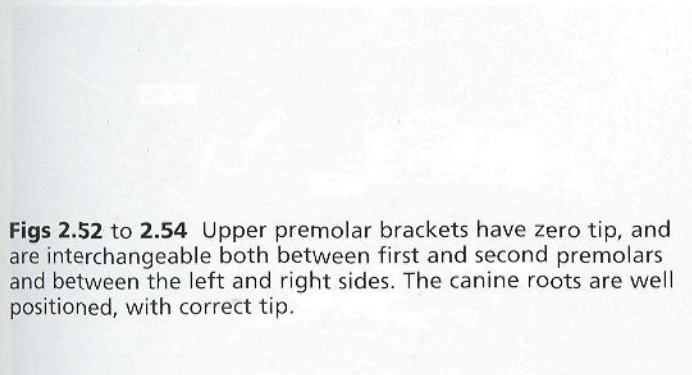


Fig. 2.51 The 0° tip feature of the premolar brackets allows them to be interchangeable between left and right sides, and between first and second premolars.



Figs 2.52 to 2.54 Upper premolar brackets have zero tip, and are interchangeable both between first and second premolars and between the left and right sides. The canine roots are well positioned, with correct tip.

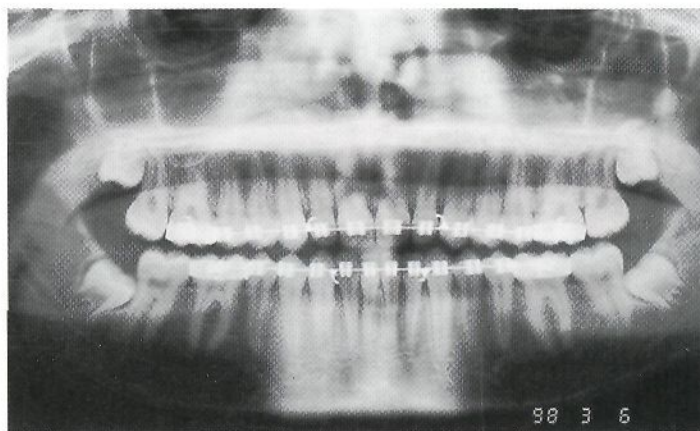


Fig. 2.53

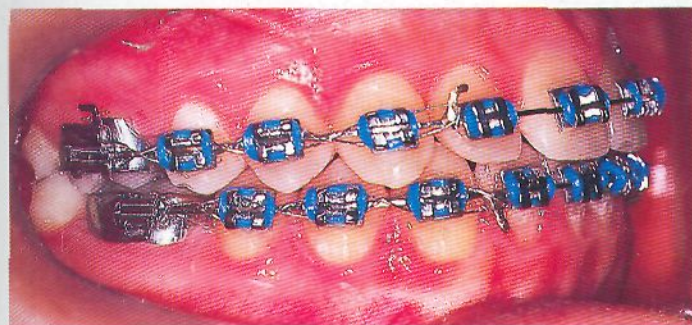


Fig. 2.52



Fig. 2.54

Use of upper second molar tubes on first molars in non-HG cases

The recommended specification for upper first and second molars is -14° torque, 0° tip, and 10° anti-rotation. The upper second molar tube may therefore be used on the upper first molars, for cases where headgear will not be required (Figs 2.55 & 2.56).

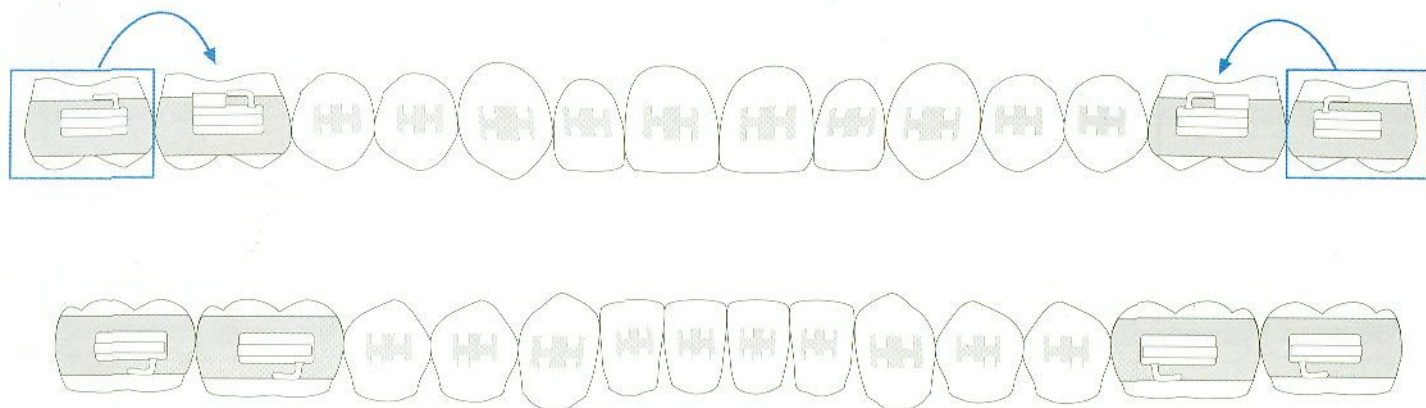


Fig. 2.55 Upper second molar attachments may be used on upper first molars in cases where headgear is not required.



Fig. 2.56 This non-extraction case did not require headgear support, and an upper second molar tube was bonded onto the upper first molar.

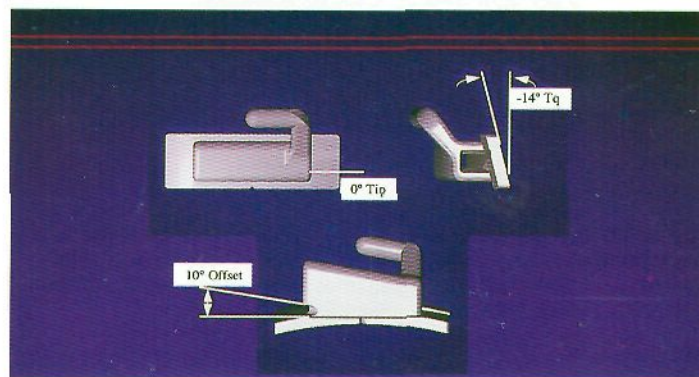


Fig. 2.57 The upper second molar tube may be used on upper first molars for cases where headgear is not needed.

Use of lower second molar tubes for the upper first and second molars of the opposite side, when finishing cases in a Class II molar relationship

It is often difficult to achieve good finishing and detailing in cases which are treated to a Class II molar relationship, after extraction of two premolars in the upper arch only.

It helps if upper molar tubes can be used which will deliver zero rotation (compared with the normal 10° rotation) and zero tip (compared with the normal 5° tip). This versatility

can be achieved by using lower second molar tubes for the upper molars, and changing sides, left going to right, and right to left (Figs 2.58–2.60). Also the tube is placed at a different tip position, with more enamel from the mesial cusp visible than from the distal cusp. This introduces the necessary tip adjustment.

In some of these cases, it is correct to use normal upper molar tubes to achieve most of the treatment objectives, and then to switch to lower second molar tubes for finishing. The lower second molar tubes may be used from the outset in cases where a lot of treatment mechanics will not be needed.

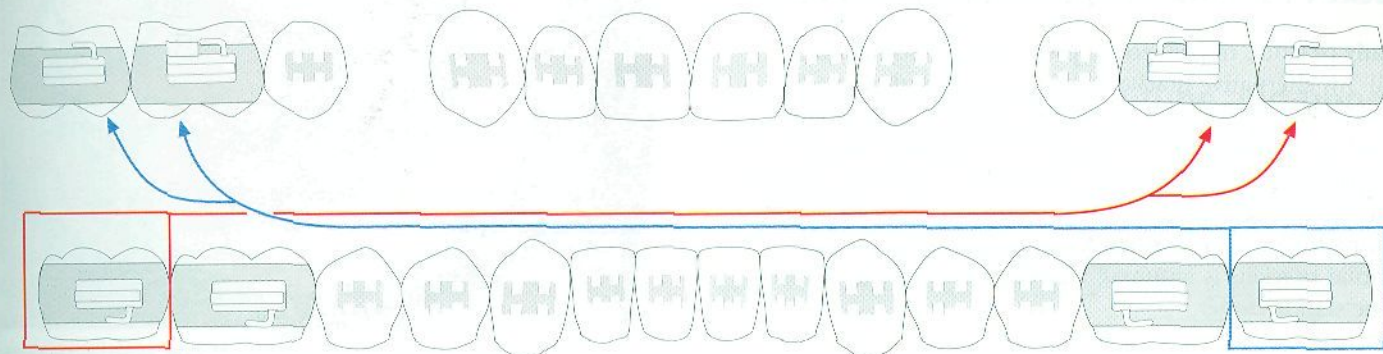
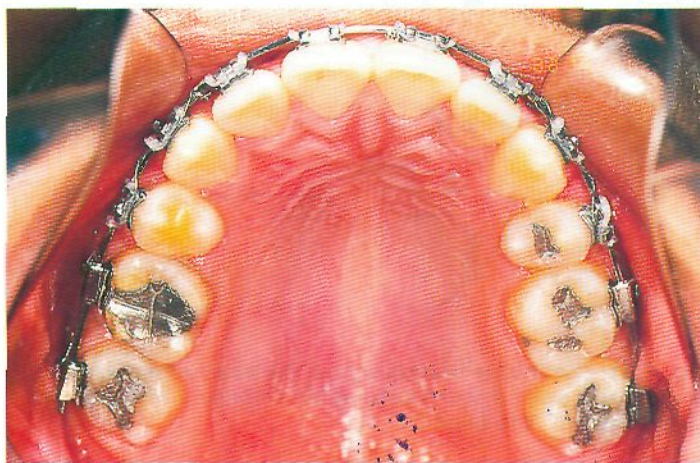
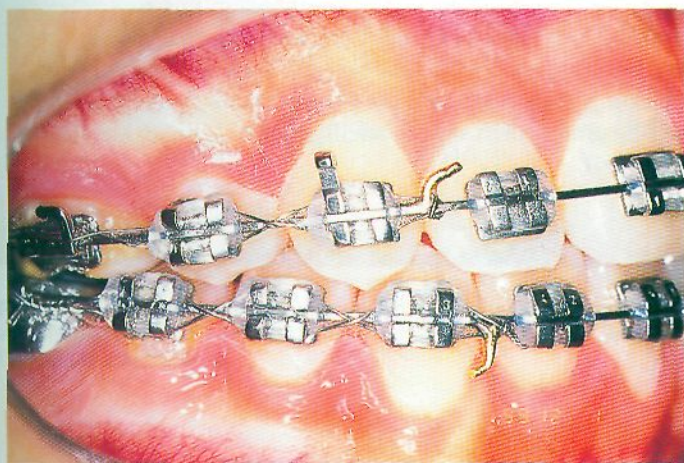


Fig. 2.58 When finishing cases in a Class II molar relationship, it can be helpful to place lower second molar attachments on upper first and second molars of the contralateral side during the finishing stages. The lower attachments have 0° rotation, and normally in these cases it is appropriate to encourage upper molars to rotate mesio-palatally. A 0° rotation molar attachment is therefore preferable to the normal upper molar attachment, which has 10° rotation.



Figs 2.59 and 2.60 A decision was made to treat this case to a Class II molar result. Lower second molar tubes, which have zero rotation, are being used on the contralateral side of the upper arch on first and second molars to assist in achieving good molar occlusion.

ADDITIONAL BRACKET AND TUBE OPTIONS

Since the bracket system was released in May 1997, the MBT™ treatment philosophy has been continually evolving and improving, in response to clinical experience and user input. The option of the thicker upper second premolar bracket has been available from the outset, but other useful options have been added since the initial release, which have further enhanced the versatility. Some of them are reviewed below.

Bracket for small upper second premolars

In daily practice, upper second premolars are sometimes small. An alternative bracket, which is 0.5mm thicker than normal, is useful for such teeth (Fig. 2.61). This bracket is helpful in obtaining good alignment of marginal ridges in cases with small upper second premolars. It requires care with bonding, as its greater prominence makes it more vulnerable to biting forces. Only a small inventory of upper second premolar brackets is required, and this should be monitored by one staff member.

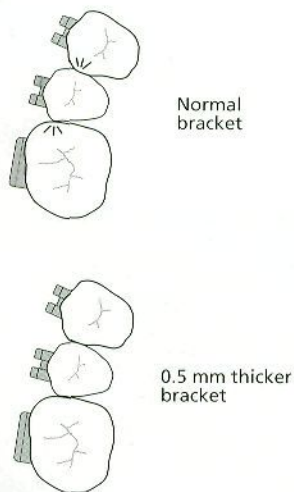


Fig. 2.61 The thicker bracket option for small upper second premolars is helpful in achieving good alignment of marginal ridges without wire bending.

Lower second premolar tubes

These were developed and tested in 2000, and are likely to find a place in the future of orthodontic treatment mechanics. This radical development has been made possible by the flexibility of the .016 HANT wires, which can easily be threaded through lower second premolar tubes at the start of treatment, even if there are slight rotations present (Fig. 2.62).

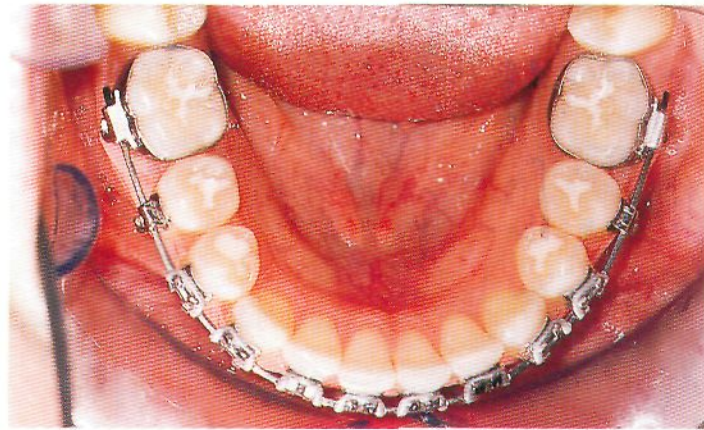


Fig. 2.62 Lower second premolar tubes viewed from the occlusal. A rectangular HANT wire has been placed without difficulty.

Lower second premolar tubes are cleaner and more comfortable than conventional brackets. Their reduced bulk causes fewer interferences and breakages in this area, where in the past breakages have often occurred. Normal sliding mechanics (Figs 2.63 & 2.64) can be achieved in a virtually friction-free manner, and the lower second premolar tubes are self-ligating, which saves a small amount of chairside time at each visit.



Fig. 2.63 Appliance breakages in the lower second premolar regions are frequently encountered, even with careful bonding, when regular brackets are used.

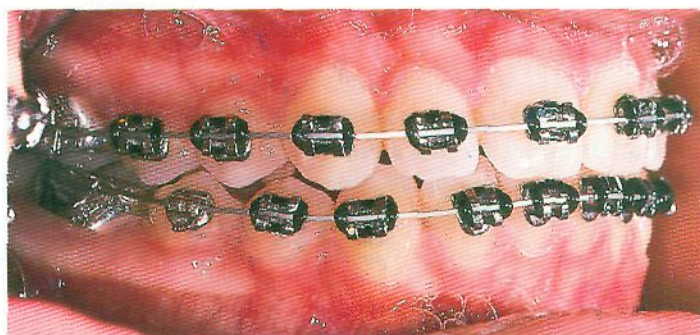


Fig. 2.64 The lower second premolar tube is more comfortable and is normally less liable to breakages than the equivalent bracket.

Lower first molar non-convertible tubes

These have many advantages over the more bulky convertible lower first molar attachments. Tubes are more comfortable, cleaner, and stronger than the conventional convertible brackets (Fig. 2.65). Their reduced bulk causes fewer interferences in this important area, and this in turn makes it easier to achieve accurate vertical bracket positioning. For these reasons, lower first molar non-convertible tubes are becoming the attachment of choice in many practices, in preference to the more bulky convertible lower first molar attachments.

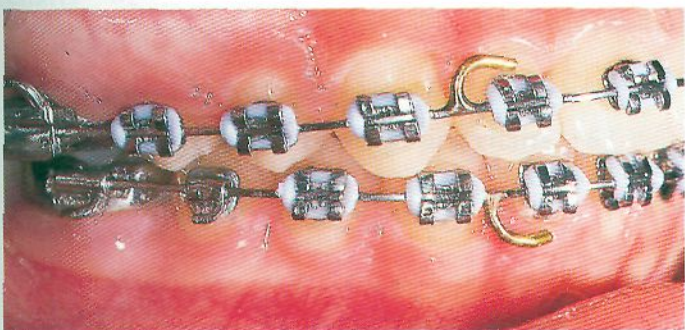


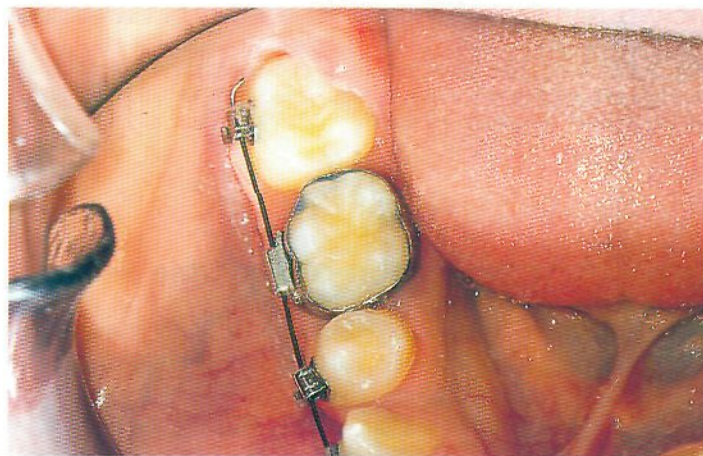
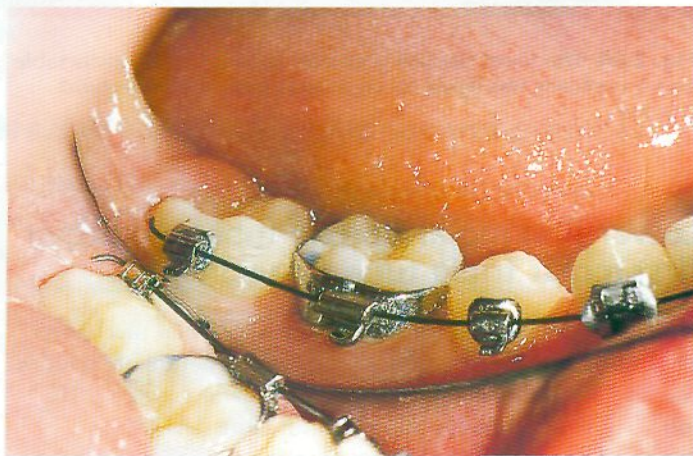
Fig. 2.65 Lower first molar non-convertible tubes have many advantages over the traditional, more bulky, convertible lower first molar attachments.

Lower first molar double tube and upper first molar triple tube attachments

These were introduced for cases where segmental mechanics are appropriate for the case. Segmental mechanics are seldom used by the authors, and they generally favor a gingival HG tube. These attachments are useful for clinicians who previously have used a segmental approach, and are in transition to the MBT™ philosophy, which is based on full arch mechanics.

Bondable mini second molar tubes

In instances where a second molar needs to be included, but the tooth is insufficiently erupted for band placement, a small tube can be bonded to the mesio-buccal area (Figs 2.66 & 2.67). These are comfortable and surprisingly effective for aligning the second molar.



Figs 2.66 and 2.67 In this case, viewed from the buccal and the occlusal, tubes are in place on the lower second premolar and both lower molars. The bondable mini second molar tubes (3M Unitek 066-5044, 066-5033) are most useful when the lower second molar is only partly erupted, and are surprisingly effective in clinical use.

REFERENCES

- 1 Andrews L F 1972 The six keys to normal occlusion. *American Journal of Orthodontics* 62:296-307
- 2 Sebata E 1980 An orthodontic study of teeth and dental arch form on the Japanese normal occlusions. *The Shikwa Gakuho* 80(7):945-969
- 3 Watanabe K, Koga M, Yatabe K, Motegi E, Isshiki Y A 1996 A morphometric study on setup models of Japanese malocclusions. *The Shikwa Gakuho*
- 4 Bennett J, McLaughlin R P 1997 *Orthodontic management of the dentition with the preadjusted appliance*. Isis Medical Media, Oxford (ISBN 1 899066 91 8) pp. 283-288. Republished in 2002 by Mosby, Edinburgh (ISBN 07234 32651)
- 5 Sandstrom R A, Klapper L, Papaconstantinou S 1988 Expansion of the lower arch concurrent with rapid maxillary expansion. *American Journal of Orthodontics* 94:296-302

Bracket positioning and case set-up

Introduction 57

The need for accuracy 57

Patient management 57

Full or partial set-up? 58

Theory of bracket positioning – avoiding errors 59

Horizontal accuracy during bracket positioning 60

Axial accuracy 61

Vertical accuracy 61

Vertical bracket positioning with gauges and charts 62

Clinical use of gauges 62

Recommended bracket-positioning chart 63

Individualized bracket-positioning charts 63

Placing molar bands 66

Separation 66

Upper molar band placement 66

Upper molar bands – rapid maxillary expansion cases 66

Lower molar band placement 67

Direct bonding of brackets 68

Indirect bonding of brackets 69

Advantages of indirect bonding 69

Disadvantages of indirect bonding 69

INTRODUCTION

Setting up of the case is the most important aspect of the treatment, after correct diagnosis and treatment planning. Banding and bonding should therefore not be delegated and should be managed by the orthodontist, to ensure accuracy of appliance placement.

The need for accuracy

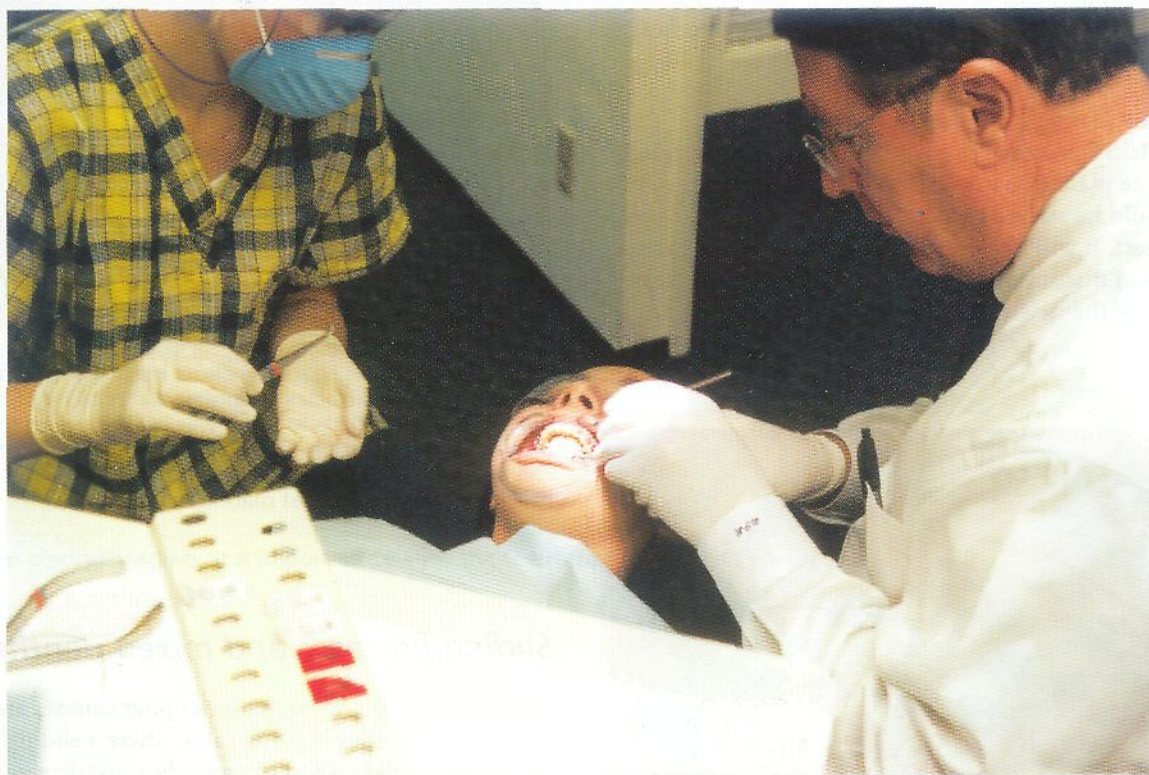
Accuracy of bracket positioning is essential, so that the built-in features of the bracket system can be fully and efficiently expressed. This helps treatment mechanics and improves the consistency of the results.

Patient management

A calm and unhurried approach to the case set-up helps to minimize patient apprehension and discomfort. This builds early patient confidence, and can raise the level of cooperation later in the treatment.¹

Proper post-set-up advice should be given, as discussed in Chapter 5 (p. 112).

The use of light-cured systems for bonding brackets and cementing bands is helpful. These reduce time pressure on the orthodontist when setting up cases. The bonding materials should be carefully used exactly to the manufacturer's recommendations, with correct light, to ensure good bond strength and reduce the risk of bond failure.



FULL OR PARTIAL SET-UP?

For many patients, it is correct to place all the brackets and bands at the start of treatment so that any discomfort is limited to one episode, and all the teeth start to be corrected from the outset. However, in some situations, listed below, it may be beneficial to consider partially setting up the case, leaving individual teeth, and in some instances groups of teeth, without attachments.

Blocked-out teeth

If individual teeth are vertically or horizontally displaced from the primary arch form (Fig. 3.1), it is often good technique to delay bracketing the displaced tooth until the other teeth are well aligned, and space has been made available.

Deep-bite cases

The methods of starting deep-bite cases are shown on pages 134 and 135. In some cases, when it has been decided not to use a bite plate or occlusal build-up, upper arch treatment should be started first. Later, after the overbite has started to correct, it will be possible to place the lower incisor brackets without discomfort to the patient or risk of damage to the enamel or the newly placed brackets.

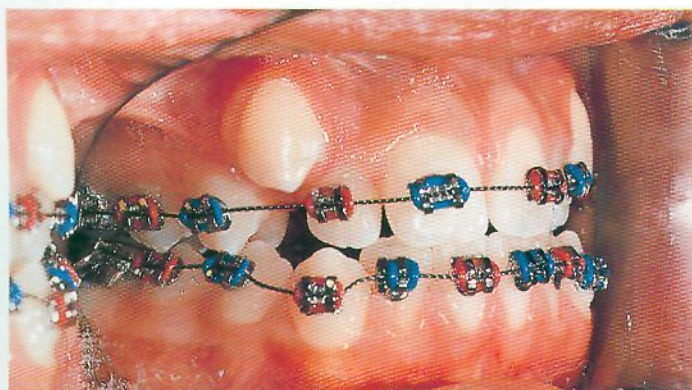


Fig. 3.1 This vertically and horizontally displaced upper right canine was not bracketed at the start of treatment. It was necessary to create space before attempting to bring it into the line of the arch.

Enamel reduction cases

It is normally necessary to carry out enamel reshaping in cases with triangular-shaped incisors (Fig. 3.2). It may be helpful to delay bracketing the incisors, especially in the lower arch. If lower incisors are bracketed at the start of treatment, they will inevitably procline a little during tooth alignment, especially in a non-extraction case. Subsequent enamel reduction, followed by retroclination is a form of round tripping. This undesirable effect can be avoided by not bracketing lower incisors at the outset.



Fig. 3.2 Triangular-shaped incisors normally require reshaping to avoid unesthetic black triangles. It can be helpful to delay placement of brackets in the lower incisor region to reduce unwanted proclination early in treatment. Treatment mechanics can be easier if lower incisors of a triangular shape are re-shaped before bracket placement.

Sliding jig cases and mixed dentition cases

Upper bicuspids and sometimes upper canines are normally not bracketed when starting cases where a sliding jig (Case TC, p. 195) will be used to control or distalize upper molars.

In many mixed dentition treatments, only the permanent teeth are included in the set-up. Primary teeth may be included in some cases, either to improve the strength and stability of the appliance, or to influence the position of the primary teeth.

THEORY OF BRACKET POSITIONING – AVOIDING ERRORS

Every effort should be made to achieve accurate bracket positioning. Ideal positioning can result in cases which show good occlusion with little effort, and will make the finishing stages of the treatment easier. This helps efficiency in a busy orthodontic practice.

With the original edgewise appliance, bracket placement was normally carried out using gauges and standard millimeter measurements from the incisal or occlusal edge of each tooth, irrespective of tooth size. With this system, patients with large incisors had brackets placed more incisally than patients with small teeth, relative to the size of the teeth. The brackets were positioned at different curvature on the teeth, and this in turn led to variations in the amount of torque and in-out produced by the brackets. However, because archwire bending was needed in any case, this system was acceptable with the edgewise appliance.

Andrews introduced the concept of the 'middle of the clinical crown', as a more reliable theoretical position for use

with the SWA, with bracket wings parallel to the long axis of the clinical crown.² This overcame the shortcomings of the original edgewise method concerning variations in the amount of torque and in-out produced by the brackets. However, as described below, it proved difficult to obtain accurate vertical positioning using only the middle of the clinical crown. Many vertical errors occurred, and the authors now advocate the use of gauges, but with individualized bracket-positioning charts (p. 63). These adhere to Andrews' principle of the middle of the clinical crown but ensure greater vertical accuracy, with less need for re-bracketing.

When direct bonding brackets, it is helpful to avoid viewing teeth from the side, or from above or below. To properly view the teeth during bonding procedures it will be necessary for the patient to turn the head, and the orthodontist to change seating position from time to time (Fig. 3.3).

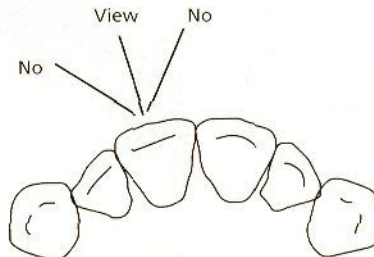
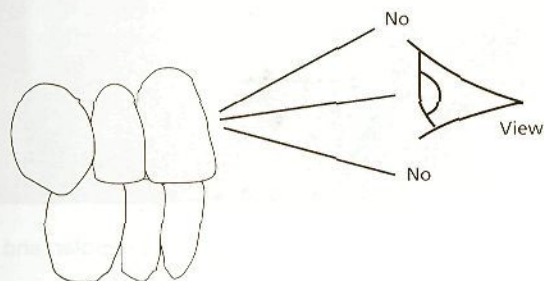


Fig. 3.3 When placing brackets, it is important to view the teeth from the correct perspective.

Horizontal accuracy during bracket positioning

Incisors and molars have relatively flat facial and buccal surfaces, and small errors do not significantly affect the position of these teeth (Fig. 3.4). Canines and premolars have more rounded facial surfaces, and therefore accuracy is important because errors in horizontal bracket positioning cause rotations. Viewing canines, premolars, molars, and rotated incisors occlusally or incisally with a mouth mirror (Fig. 3.6) helps bracket positioning relative to the vertical long axis of the crown. Lower canine brackets should be placed on the vertical midline, or slightly mesial to it, to ensure good contact with the lateral incisors (Fig. 3.7).

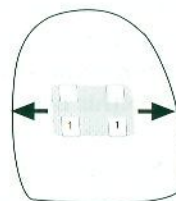


Fig. 3.4 Errors in horizontal bracket positioning cause rotations.



Fig. 3.5 Horizontal and vertical accuracy can be checked from the buccal aspect.



Fig. 3.6 Horizontal accuracy in the canine, premolar, and molar regions should be checked with a mouth mirror.

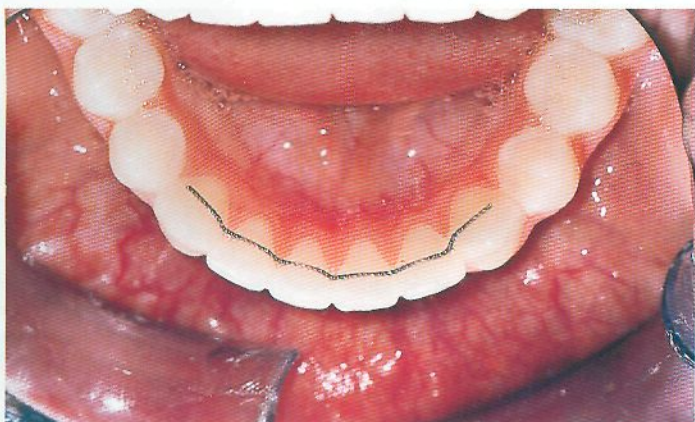


Fig. 3.7 In this case, the lower canine brackets were bonded slightly distal to the vertical midline. The resulting contacts between canines and lateral incisors are less than ideal, especially on the left side.

Horizontal accuracy during bracket positioning

Incisors and molars have relatively flat facial and buccal surfaces, and small errors do not significantly affect the position of these teeth (Fig. 3.4). Canines and premolars have more rounded facial surfaces, and therefore accuracy is important because errors in horizontal bracket positioning cause rotations. Viewing canines, premolars, molars, and rotated incisors occlusally or incisally with a mouth mirror (Fig. 3.6) helps bracket positioning relative to the vertical long axis of the crown. Lower canine brackets should be placed on the vertical midline, or slightly mesial to it, to ensure good contact with the lateral incisors (Fig. 3.7).

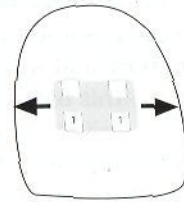


Fig. 3.4 Errors in horizontal bracket positioning cause rotations.

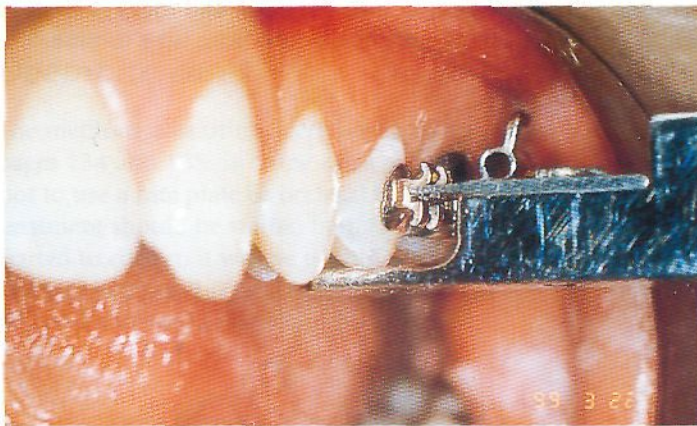


Fig. 3.5 Horizontal and vertical accuracy can be checked from the buccal aspect.

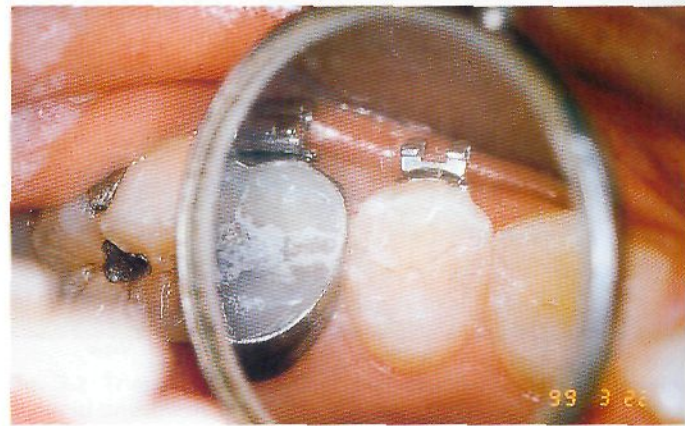


Fig. 3.6 Horizontal accuracy in the canine, premolar, and molar regions should be checked with a mouth mirror.

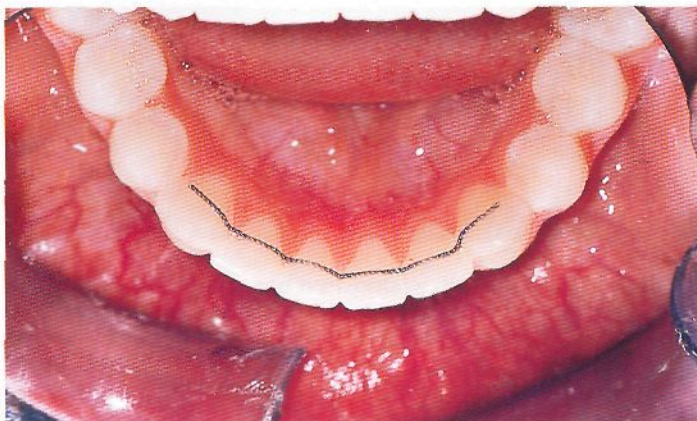


Fig. 3.7 In this case, the lower canine brackets were bonded slightly distal to the vertical midline. The resulting contacts between canines and lateral incisors are less than ideal, especially on the left side.

Rotated incisors

Slight mesial or distal adjustment is helpful when bracketing rotated incisors. On a rotated tooth, the bracket can be bonded slightly more mesially or distally, sometimes with a very small amount of excess composite under the mesial or distal of the bracket base. In this way, full correction of the rotation can be achieved with no special measures (Fig. 3.8).

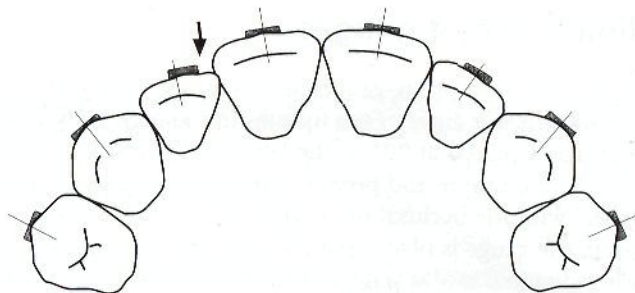


Fig. 3.8 On a rotated tooth, the bracket can be bonded slightly more mesially or distally. In this way, full correction of the rotation can be achieved.

Axial accuracy

It is necessary to accurately visualize the vertical long axis of the clinical crown of each tooth (Fig. 3.9) to achieve accuracy, because errors will cause incorrect tip position of teeth. The bracket wings need to be parallel to the long axis and to evenly straddle it. It is helpful to disregard the incisal edges of incisors.

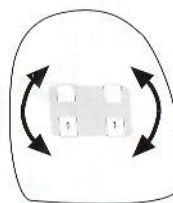


Fig. 3.9 To achieve axial accuracy it is necessary to visualize the vertical long axis of the crown of each tooth.

Vertical accuracy

This is the most difficult aspect (Fig. 3.10) of bracket positioning, and accuracy is greatly improved by the use of gauges and an individualized bracket-positioning chart (p. 65). This will deal with difficulties such as tooth length discrepancies, labially and lingually displaced roots, partly erupted teeth, and gingival hyperplasia which have been previously reported.³

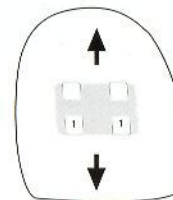


Fig. 3.10 Vertical accuracy is the most difficult aspect of bracket positioning.

VERTICAL BRACKET POSITIONING WITH GAUGES AND CHARTS

Clinical use of gauges

The bracket-positioning gauges are used in slightly different ways in different areas of the mouth. In the incisor regions, the gauge is placed at 90° to the labial surface (Figs 3.11 & 3.12). In the canine and premolar regions, the gauge is placed parallel with the occlusal plane (Fig. 3.13). In the molar region, the gauge is placed parallel with the occlusal surface of each individual molar (Fig. 3.14).

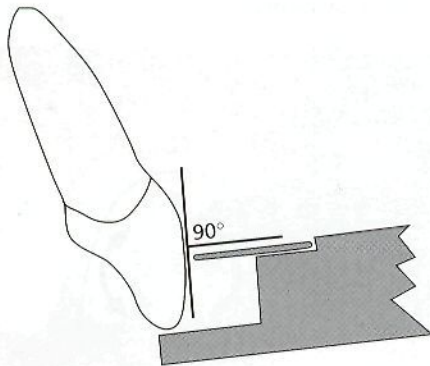


Fig. 3.11 In the incisor region, the gauge is placed at 90° to the labial surface.

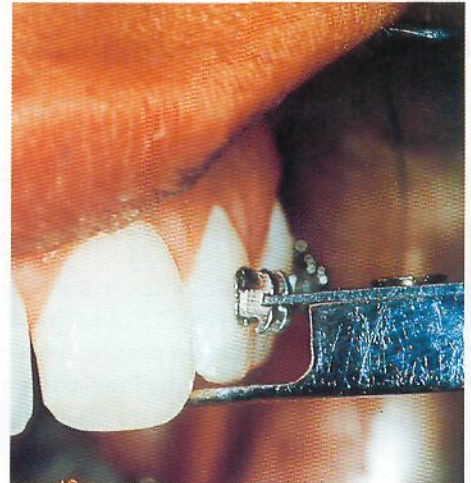


Fig. 3.12 In the incisor region, the gauge is placed at 90° to the labial tooth surface.

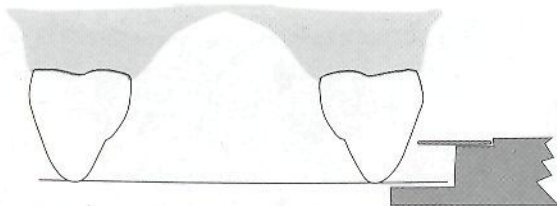


Fig. 3.13 In the canine and premolar regions, the gauge is placed parallel with the occlusal plane.

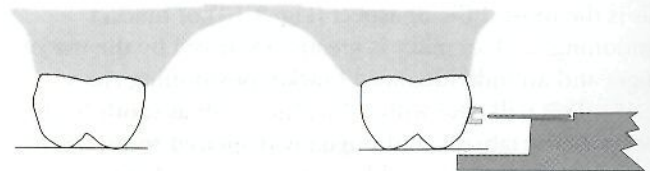


Fig. 3.14 In the molar regions, the gauge is placed parallel with the occlusal surface of each individual molar.

Recommended bracket-positioning chart

In the early 1990s, because of continuing difficulties with vertical bracket positioning, the authors investigated the location of the center of the clinical crown.⁴ A recommended bracket-positioning chart was published, and is shown in Table 3.1. It was recommended that the tooth size for the patient be determined, by measuring either fully erupted teeth in the mouth, or teeth on plaster models. A row could then be chosen for the upper arch and a row for the lower arch, and gauges used to position the brackets at the vertical heights shown in the chosen row.

Individualized bracket-positioning charts

The recommended bracket-positioning chart can be used for many cases. However, individualized bracket-positioning charts are increasingly used, and are shown in Figures 3.15 and 3.16. It takes little time to produce a handwritten chart for each patient, which can be included in the notes and referred to at the case set-up and throughout treatment as necessary. This is equally useful whether using direct or indirect bonding techniques.

Table 3.1 Recommended bracket-positioning chart							
7	6	5	4	3	2	1	Upper
2.0	4.0	5.0	5.5	6.0	5.5	6.0	+ 1.0 mm
2.0	3.5	4.5	5.0	5.5	5.0	5.5	+ 0.5 mm
2.0	3.0	4.0	4.5	5.0	4.5	5.0	Average
2.0	2.5	3.5	4.0	4.5	4.0	4.5	-0.5 mm
2.0	2.0	3.0	3.5	4.0	3.5	4.0	-1.0 mm
7	6	5	4	3	2	1	Lower
3.5	3.5	4.5	5.0	5.5	5.0	5.0	+ 1.0 mm
3.0	3.0	4.0	4.5	5.0	4.5	4.5	+ 0.5 mm
2.5	2.5	3.5	4.0	4.5	4.0	4.0	Average
2.0	2.0	3.0	3.5	4.0	3.5	3.5	-0.5 mm
2.0	2.0	2.5	3.0	3.5	3.0	3.0	-1.0 mm

Upper right															Upper left
Average for adults	2.0	3.0	4.0	4.5	5.0	4.5	5.0	5.0	4.5	5.0	4.5	4.0	3.0	2.0	Average for adults
Lower right	2.5	2.5	3.5	4.0	4.5	4.0	4.0	4.0	4.0	4.5	4.0	3.5	2.5	2.5	Lower left
Upper right															Upper left
Average for children	2.0	2.5	3.5	4.0	4.5	4.0	4.5	4.5	4.0	4.5	4.0	3.5	2.5	2.0	Average for children
Lower right	2.0	2.0	3.0	3.5	4.0	3.5	3.5	3.5	3.5	4.0	3.5	3.0	2.0	2.0	Lower left

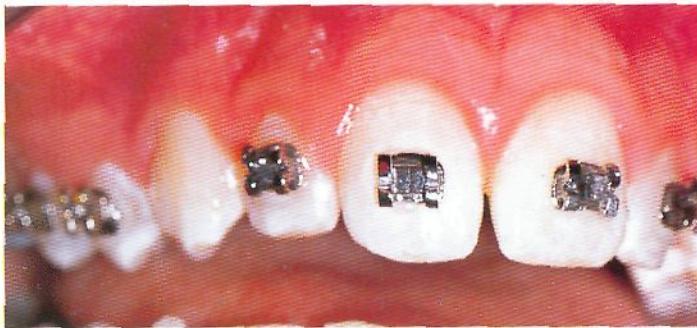
Fig. 3.15 Individualized bracket-positioning chart – before completion. It is helpful to have an adult and a child version available.

Upper right															Upper left
Average for children	2.0	2.5	3.5	4.0	<i>5.0</i>	4.0	<i>5.0</i>	4.5	4.0	<i>5.0</i>	4.0	3.5	2.5	2.0	Average for children
Lower right	2.0	2.0	3.0	3.5	4.0	3.5	3.5	3.5	3.5	4.0	3.5	3.0	2.0	2.0	Lower left

Fig. 3.16 Individualized bracket-positioning chart – after completion, for a child with pointed upper cuspids and a chipped upper right central incisor.

1. Chart individualization for some upper canines and lower first premolars

It is helpful in some cases to place upper canine and lower first premolar brackets 0.5 mm more gingivally, especially in cases with pointed teeth.



2. Chart individualization in cases with abnormal incisal edges

Some cases may have teeth with wear or chipping of the incisal edges, or with crowns that are pointed or have developmental irregularities. The use of gauges and a standard bracket-positioning chart will not deal with chipped or worn teeth, or teeth of abnormal anatomy, such as pointed canines.

In some cases, it will be easier to judge the correct amount of incisal enamel adjustment needed after the teeth have been aligned. In others, the patient may be reluctant to agree to enamel adjustments at the start of treatment, and these have to be made as treatment progresses. For such patients, it is necessary to estimate the final shape of the incisal edge and the length of the crowns, and amend the individualized bracket-positioning chart accordingly.

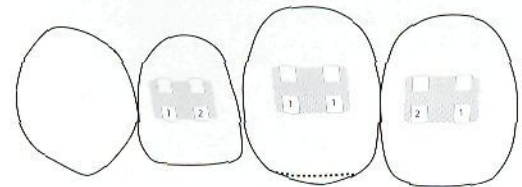


Fig. 3.17 This patient shows difficult barrel-shaped teeth. The bracket on the upper right central incisor was bonded 0.5 mm more gingivally, in anticipation of the need for reshaping of the incisal edge.

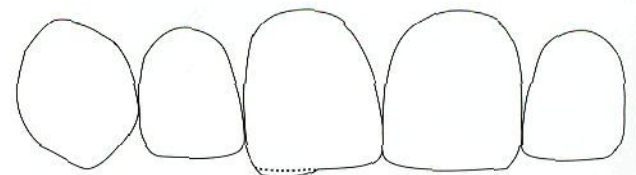


Fig. 3.18 This upper right lateral incisor edge should be reshaped before treatment, or else the bracket should be placed 0.5 mm more gingivally.

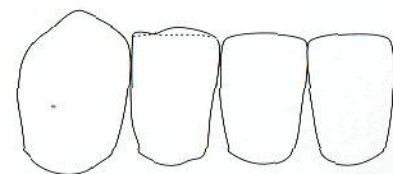


Fig. 3.19 This lower right lateral incisor edge should be reshaped before treatment, or else the bracket should be placed 0.5 mm more gingivally than for the other incisors.

3. Chart individualization in deep-bite and open-bite cases

It can be helpful to place the incisor and canine brackets 0.5 mm more occlusally in deep-bite cases. In open-bite cases, they should be 0.5 mm more gingival.

4. Chart individualization in premolar extraction cases

In premolar extraction cases, the height of molar attachments is individualized to avoid vertical steps at the extraction sites. In first premolar extraction cases, the adjustment needs to include the second premolar bracket positions also (Fig. 3.20), for the vertical relationships between the marginal ridges of canines and second premolars. In second premolar extraction cases, only the height of molar attachments is individualized (Fig. 3.21). This will ensure good vertical relationships between the marginal ridges of first premolars and first molars.

Upper right															Upper left
Average for children	2.0	2.5 ^{3.0}	3.5 ^{4.0}	4.0	4.5	4.0	4.5	4.5	4.0	4.5	4.0 ^{4.0}	3.5 ^{3.0}	2.0		
Lower right	2.0 ^{2.5}	2.0 ^{2.5}	3.0 ^{3.5}	3.5	4.0	3.5	3.5	3.5	3.5	4.0	3.5	3.0 ^{3.5}	2.0 ^{2.5}	2.0 ^{2.5}	
															Lower left

Fig. 3.20 Individualized bracket-positioning chart for a first premolar extraction case.

Upper right													Upper left	
Average for children	2.0	2.5	3.5	4.0	4.5	4.0	4.5	4.5	4.0	4.5	4.0	3.5	2.5	2.0
	2.0	2.0	3.0	3.5	4.0	3.5	3.5	3.5	3.5	4.0	3.5	3.0	2.0	2.0
Lower right													Lower left	

Fig. 3.21 Individualized bracket-positioning chart for a second premolar extraction case.

PLACING MOLAR BANDS

Separation

Good separation is necessary (Figs 3.22 & 3.23). It assists accurate band placement and makes the procedure more comfortable for the patient. Ideally, elastic separating modules should be in place for about a week. Less than a week can cause sensitivity of the teeth during band placement. There is a greater risk of separators falling out if they are left in for more than a week.

It is sometimes difficult to place elastic separators in the second molar regions, and metal separators (353-020) from TP (Fig. 3.23) can be helpful in this area. Normal gray elastomeric modules can sometimes be used between small premolar contact points.

Upper molar band placement

The upper molar tube should straddle the buccal groove, and this can be checked by viewing from the occlusal (Fig. 3.25). Care is needed to prevent the distal aspect of the band from seating too gingivally, and band-seating pressure is therefore applied at the mesial palatal aspect initially, and then the distal palatal aspect. The band should be checked from the buccal to ensure it is parallel with the buccal cusps (Fig. 3.24). It is helpful if the tube is welded more to the occlusal on the band, rather than to the gingival, especially for the second molar.

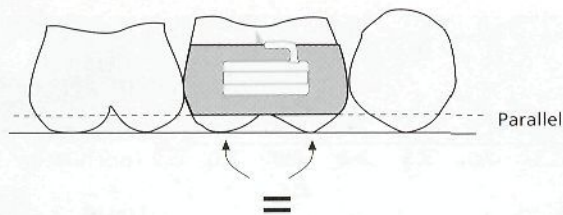


Fig. 3.24 When viewed from the buccal, the tube and band should be parallel with the buccal cusps.

Upper molar band selection for rapid maxillary expansion (RME) cases

A different technique is recommended for RME cases. After good separation, bands are selected which are one size too large. They should then be temporarily cemented in place with small amounts of glass ionomer cement, to ensure that they remain in an ideal position during impression taking. After impression taking, the bands can be removed, cleaned, and sent to the laboratory. Separators should then be replaced until the RME appliance can be cemented a few days later.

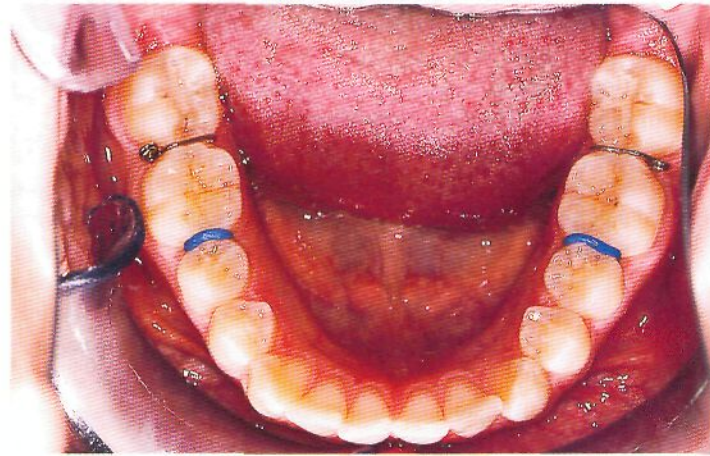


Fig. 3.22 Blue S2 separators (3M Unitek 406-084) are preferred when possible. Good separation is necessary for accurate band placement.

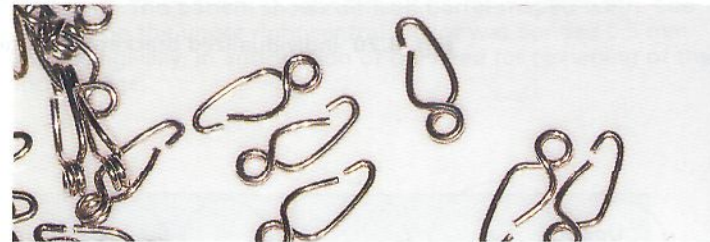


Fig. 3.23 Metal separators (TP 353-020) are sometimes useful in contact areas between molars, especially distal to upper first molars.

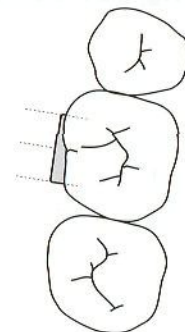


Fig. 3.25 When viewed from the occlusal, the upper molar tube should straddle the buccal groove.

Lower molar band placement

The lower second molar tube should straddle the buccal groove, and the lower first molar tube should straddle the mesio-buccal groove (Fig. 3.26). This should be checked by viewing from the occlusal. Care is needed when banding larger lower first molars to ensure that the tube is not placed too far mesially, and also to prevent the mesial aspect of lower molar bands from seating too gingivally (Figs 3.27 & 3.28). Lower molar bands should be checked from the buccal to ensure they are parallel with the buccal cusps. It is an error to allow the mesial aspect of the band to seat too gingivally (Fig. 3.28). It is helpful if the tube is welded more to the occlusal on the band (ideally at 2.0 mm or 2.5 mm), rather than to the gingival.

Convertible tubes are more bulky than non-convertible tubes, leading to occlusal interferences, and the tendency to place the band too gingivally. It is therefore easier to place lower bands with non-convertible tubes (Fig. 3.29).

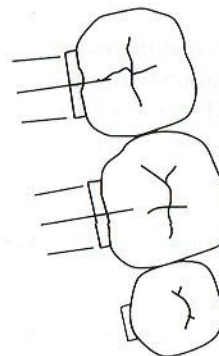


Fig. 3.26 The lower molar tube should straddle the buccal groove. With large lower first molars, it may be helpful to place the tube a little distal of this position.

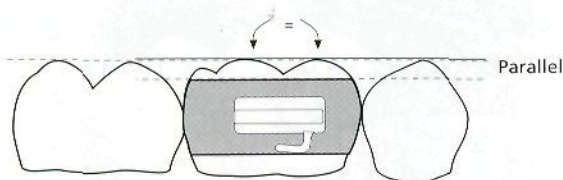


Fig. 3.27 The mesial of the lower first molar band should not be seated too low.



Fig. 3.28 It is an error to allow the mesial of the lower molar bands to seat too gingivally, as happened in this case.

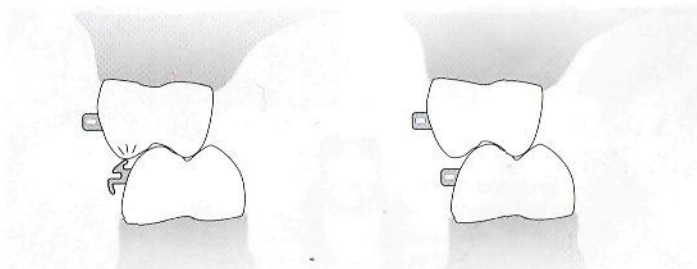


Fig. 3.29 Lower molar non-convertible tubes are often preferable to convertible tubes, because they are less bulky. They are stronger, more comfortable, and cause fewer interferences.

DIRECT BONDING OF BRACKETS

After cleaning of the enamel surface, etching, and application of primer, the positioning and bonding of the bracket are carried out in five stages:

1. The bracket is positioned at the estimated mid-point of the clinical crown, with bracket wings parallel to the long axis of the clinical crown. The bracket is then pressed three-quarters of the way on to the tooth surface at this position (Fig. 3.30A).
2. Excess bonding agent is then removed (Fig. 3.30B).
3. Vertical position is checked with a gauge, to equal the individualized bracket-positioning chart (Fig. 3.30C).
4. Rotational and horizontal positioning is re-checked, and then the bracket is pressed fully on to the enamel surface (Fig. 3.30D).
5. Any additional excess of bonding material is removed before light-curing (Fig. 3.30E).

								Upper left
	4.5	4.0	4.5	4.0	3.5	2.5	2.0	Average for children
	3.5	3.5	4.0	3.5	3.0	2.0	2.0	Lower left



Fig. 3.30A Positioning at the estimated mid-point of the clinical crown, with bracket wings parallel to the long axis of the crown.

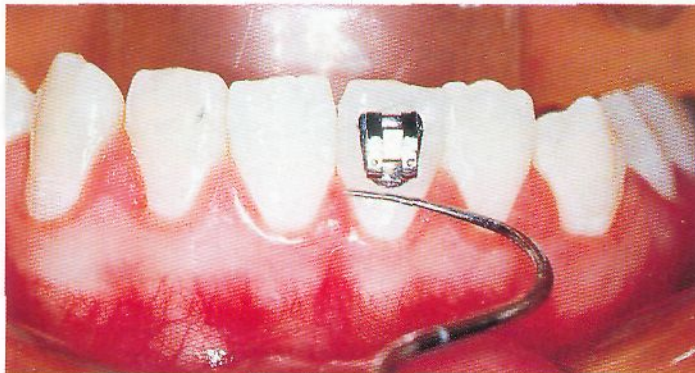


Fig. 3.30B Removal of excess bonding agent.

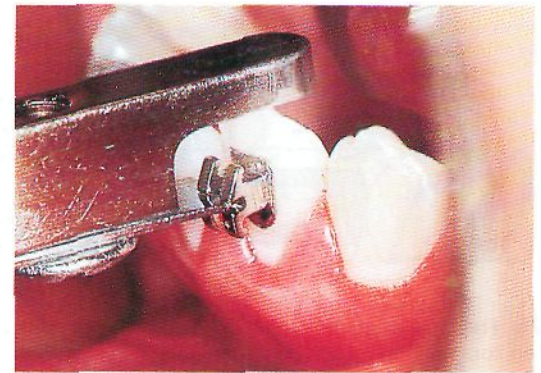


Fig. 3.30C Checking vertical positioning.



Fig. 3.30D Re-checking axial and horizontal positioning.



Fig. 3.30E Light-curing after removal of any additional excess bonding material.

INDIRECT BONDING OF BRACKETS

There is currently renewed interest in indirect bonding, owing to the improved adhesives which have been developed, better tray materials, and upgraded design of retractors, such as the Nola™ retractors used in the Nola™ Dry Field system. This upsurge in interest is partly driven by the acceptance within the orthodontic specialty that accuracy of bracket positioning is vital to success in modern orthodontics, and that indirect bonding techniques, if carefully used, can provide greater accuracy.

In 1999, Sondhi reported on a new resin, specifically designed for indirect bonding.⁵ He recommended making a light-cured adhesive base for each bracket and then indirect bonding with the new chemical-cured material. The viscosity of the Sondhi material was improved by the use of 5% fine particle fumed silica filler, which also helped to fill any small discrepancies between enamel and the custom base, and curing was complete in 2 minutes. This material has seen widespread acceptance.

Currently, many improvements are being introduced and evaluated and it is beyond the scope of this book to give full details and recommendations concerning indirect bonding technique. The reader is referred to the publications by Sondhi³ and also the technique advocated by Kalange⁶ using the Sondhi material, as well as the manufacturer's literature.

ADVANTAGES OF INDIRECT BONDING

Indirect bonding is more accurate, especially in the molar regions, and has the advantage that no separation appointment is needed. The technique reduces the amount of chairside time for the orthodontist, and also the patient has a shorter appointment for the case set-up.

It may be preferable to band the upper molars if a headgear is to be used, because posterior bands are stronger than bonds. Otherwise there are no bands on the posterior teeth, which assists in oral hygiene control. It has been recommended that brackets should always be used in

preference to bands for patients with a history of bacterial endocarditis.⁷ Indirect bonding is therefore useful for this small group of patients, who need to maintain a very high level of plaque control, and who should rinse twice daily⁷ with chlorhexidine 0.2% mouthwash for 2 days prior to the set-up appointment, and also prior to subsequent adjustment visits.

DISADVANTAGES OF INDIRECT BONDING

An extra set of impressions is needed for indirect bonding cases, and the procedure is technique sensitive. Although bonding and tray construction techniques are continuing to be refined, those using indirect bonding confirm that the technique needs to be as perfect as possible, and that it is an advantage if there is a technician with suitable laboratory facilities in the practice.

Considerable laboratory time is required. After the model has been poured, the orthodontist draws a pencil line on the crown of each tooth to represent the long axis. The technician will then be able to place the brackets onto the model in approximately the correct position, and store it in a dark box. The orthodontist will subsequently position the brackets ideally, at a convenient time. The authors find that pre-coated (APC™) brackets are most efficient for laboratory use, as they are convenient, clearly identified (so that mix-ups do not occur), and free from contamination. The technician can then proceed with tray construction and the other laboratory procedures. At the time of bonding, it is important to inform the patient that the bracket positioning was carried out by the orthodontist.

Although there are disadvantages, it is likely that indirect bonding will see greater use than in the past. This is due to the need for greater accuracy in bracket positioning and because of the improved techniques and materials which are currently available.

REFERENCES

- 1 Gross A M 1990 Increasing compliance with orthodontic treatment. *Child and Family Behavioural Therapy* 12(2)
- 2 Andrews L F 1989 Straight-Wire – the concept and the appliance. Wells Co, LA
- 3 Bennett J, McLaughlin R P 1997 Orthodontic management of the dentition with the preadjusted appliance. Isis Medical Media, Oxford (ISBN 1 899066 91 8) pp. 28–40. Republished in 2002 by Mosby, Edinburgh (ISBN 07234 32651)
- 4 McLaughlin R P, Bennett J C 1995 Bracket placement with the preadjusted appliance. *Journal of Clinical Orthodontics* 29:302–311
- 5 Sondhi A 1999 Efficient and effective indirect bonding. *American Journal of Orthodontics and Dentofacial Orthopedics* 115:352–359
- 6 Kalange J T 1999 Ideal appliance placement with APC brackets and indirect bonding. *Journal of Clinical Orthodontics* 33:516–526
- 7 Roberts G J, Lucas V S, Omar J 2000 Bacterial endocarditis and orthodontics. *Journal of the Royal College of Surgeons, Edinburgh* 45:141–145

Arch form

Introduction 72

- The search for the ideal arch form 72
- Relapse tendency after changing arch form 72
- Cases where expansion may be stable 72
- Variation among human arch forms 73
- Summary of the issues facing the clinician 73

Practical solutions 74

- The use of three arch forms 74
- Recommended ratios 75
- The tapered arch form 76
- The square arch form 76
- The ovoid arch form 76

Systemized management of arch form 77

- Standardized versus customized wires 77
- The use of clear templates at the start of treatment 77
- Arch form control early in treatment 77
- Arch form control with rectangular HANT wires 78
- Arch form control with rectangular steel wires 78
- Customizing – determining IAF for each patient 78

Modifications to arch form and archwire coordination 80

- Posterior torque considerations 80
- After maxillary expansion 80
- Upper arch expansion with archwires 81
- Upper arch expansion with a jockey wire 82
- Asymmetries 82

Arch form during finishing and detailing – the need for settling 83

Arch form considerations during retention 83

Stock control protocol for archwires 84

Case AL A Class I case with a tapered arch form 86

INTRODUCTION

During the era of standard edgewise, most orthodontists customized archwires to each patient's arch form. When the preadjusted appliance became available, there seemed to be an unwritten assumption that one arch form was appropriate, and it could be used for all cases with the preadjusted system. Time has shown that this assumption was not correct. Some customizing of the arch form for individual patients is important. In-out is built into the preadjusted appliance, which avoids the need for first-order bends. This simplifies arch form, but it does not eliminate the need to use different shapes for different individuals.

In order to properly manage arch form in a modern orthodontic practice, there needs to be a balance between efficiency (a single arch form for all patients) and accuracy (the customizing needed for case stability). In this chapter, a short literature review will be presented to support the need for this balance, followed by the description of a practical system for arch form management.

The search for the ideal arch form for the human dentition

Arch form has been discussed in dental and orthodontic publications for over a century. Many of the early attempts to explain and classify the human dental arch form involved geometric terminology such as ellipses, parabolas, and catenary curves. Ideal arch forms were described by Hawley,¹ Scott,² Brader³ and others. The authors have previously reviewed this early work,⁴ some of which was for full dentures, but feel it has little relevance to modern orthodontics. Similarly, the search for an 'ideal' arch form, suitable for every patient, has been an unrealistic goal because of the wide individual variations (p. 73).

Relapse tendency after changing arch form

In 1969, in a chapter on retention in Graber's text, Riedel⁵ reviewed previous studies on the stability of arch form. He cited numerous authors who had reported that when inter-canine and inter-molar width had been changed during orthodontic treatment, there was a strong tendency for these teeth to return to their pre-treatment position. He cited only one author who had reported the stability of a slight increase in mandibular inter-canine width after all retention had been removed for what was termed an 'adequate period'. Riedel postulated that 'arch form, particularly in the mandibular arch, cannot be permanently altered during appliance therapy.'

In 1995, De La Cruz et al⁶ reported on long-term changes in arch form of 45 Class I and 42 Class II/1 treated cases, a minimum of 10 years post-retention. They concluded that arch form tended to return toward the pre-treatment shape after retention and that the greater the treatment change, the greater the tendency for post-retention change. They suggested that the patient's pre-treatment arch form appeared to be the best guide for future arch form stability, but emphasized that minimizing treatment change was no guarantee of post-retention stability.

In 1998, Burke et al⁷ used meta-analysis to review 26 previous studies of mandibular inter-canine width. They concluded that 'regardless of patient diagnostic and treatment modalities, mandibular inter-canine width tends to expand during treatment by about 1 or 2 millimeters, and to contract post-retention to approximately the same dimension'.

The paper by Burke et al confirms the overall message from the orthodontic literature, that if arch form is changed during orthodontic treatment, in many cases there will be a tendency for relapse to the original dimensions. This is particularly true of inter-canine width. Changes in inter-molar width seem to be more stable.

Cases where expansion of lower inter-canine width may be stable

In most cases, the lower inter-canine width should not be increased during treatment, because of the risk of relapse. Felton et al⁸ pointed out that buccal uprighting will result in lower anterior relapse in approximately 70% of cases. However, the 30% of cases in which buccal uprighting will be stable will probably include:

Deep-bite cases (such as Class III/2 cases) in which lower canines have inclined lingually in response to the palatal contour of the upper canines

As the bite is opened, the lower canines can be uprighted. The overbite corrections must remain post-treatment for this movement to be stable. In 1974, Shapiro⁹ reported on changes in arch length and inter-molar width in 22 non-extraction cases and 58 extraction cases after treatment and post-retention. He concluded that mandibular inter-canine width showed a strong tendency to return to its pre-treatment dimension in all groups, with the exception of Class II/2 cases. Expansion of inter-canine width in treated Class II/2 cases showed significantly greater stability than Class I or Class II/1. Post-retention arch length reduction was also less in the Class II/2 group. Shapiro's interesting findings could

possibly be due to the fact that Class II/2 cases normally show a deep bite, with lower canines inclined lingually in relation to the palatal surface of the upper canines. When the bite is opened, the incisal edges of the lower canines may move labially (Fig. 2.46, p. 46), but the apices of the roots of these teeth may move lingually, with the bodies of the teeth remaining in the same position.

Cases where rapid maxillary expansion is indicated in the upper arch and this expansion is maintained post-treatment

Ladner and Muhl¹⁰ have reported that the lower arch will follow this with buccal uprighing, which can be stable. The amount of this response was studied by Sandstrom et al,¹¹ who observed that lower canines will upright and increase inter-canine width by an average of 1.1 mm, and molars will upright and increase inter-molar width on average 2.9 mm. This effect does not seem to produce an extensive amount of additional space in the lower arch. Haas¹² reported on aggressive upper arch expansion, and found an increase in inter-cuspid width of 3–4 mm in only 'a few cases'.

Despite the overwhelming evidence on the instability of lower arch expansion, Braun et al^{13,14} reported that the most popular nickel-titanium archwires sold by the major orthodontic companies expand the lower inter-canine width by 5.9 mm and the upper inter-canine width by 8.2 mm on average.

Variation among human arch forms

Most authors have acknowledged that there is variability in the size and shape of human arch form. For example, in 1987 Felton et al⁸ published a study to find out whether an ideal orthodontic arch form could be identified. They examined the mandibular casts of 30 untreated normal cases (from Andrews' 120 normals study), 30 Class I non-extraction cases, and 30 Class II non-extraction cases. They found that no particular arch form predominated in any of the three samples. They stated that customizing arch forms appeared to be necessary in many cases to obtain optimum long-term stability, because of the great variability in arch form observed in the study.

It is generally accepted that the dental arch form is initially shaped by the form of the underlying bone, and then after eruption of the teeth, the shape becomes influenced by the oral musculature. Genetic and environmental differences produce great variability, which is confirmed in day-to-day clinical observation.

Summary of the issues facing the clinician

Research papers and clinical observations are giving clear messages:

- There are extensive variations among human arch forms.
- As a result of these variations, there does not seem to be any single arch form that can be used for all orthodontic cases.
- If the patient's original arch form is changed during treatment, there is a strong tendency (in as much as 70% of cases) for the arch form to return to its original shape after appliances are removed.

How do the above findings affect the clinical orthodontist? Do they mean that archwires must be individually customized for each patient? Or can some form of preformed archwire system be used, which will be helpful to the orthodontist, even though some modifications may be needed?

In the following pages a systemized approach to arch form management is described and recommended.

PRACTICAL SOLUTIONS

The use of three arch forms

Arch forms were first classified as tapered, square, and ovoid by Chuck¹⁵ in 1932. Numerous authors and clinicians have used this classification over the years, and eventually orthodontic manufacturers began producing arch forms based on this classification (also referred to as narrow, normal, and broad). Such a three arch form approach allows for greater individualization than the single arch form approach, especially in the early archwire stages. If one classifies the arch forms in the Felton et al⁸ study into tapered, square, and ovoid, the ratios of these shapes in the Andrews', Class I, and Class II samples are approximately as shown in Table 4.1.

In an unpublished study in one of the authors' practices, the lower arches of 200 consecutive cases (predominantly Caucasian) were evaluated with tapered, ovoid, and square transparent templates. The results (Fig. 4.1) were that approximately 50% of the lower arch forms were tapered, 8% were square, and 42% were ovoid. This is quite similar to the Felton results.

	Tapered (%)	Squared (%)	Ovoid (%)
Andrews' cases	27	20	53
Class I sample	60	3	37
Class II sample	53	7	40

Table 4.1

Nojima et al¹⁶ used tapered, square, and ovoid templates to evaluate the arch forms of Class I, Class II, and Class III cases in both Japanese and Caucasian samples (Figs 4.2 & 4.3). The Caucasian sample showed 44% tapered arch forms, 18% square arch forms, and 38% ovoid arch forms. However, Nojima et al included an equal proportion of Class III cases (of which 44% have square arches) in both samples, and a typical Caucasian caseload would contain fewer Class III cases. Hence the ratios of 50% tapered, 8% square, and 42% ovoid are a more probable reflection of a predominantly Caucasian practice. Global differences are clearly significant, and it is interesting that the Japanese sample showed ratios of 12% tapered, 46% square, and 42% ovoid. This shows the opposite ratio of square to tapered arch forms, compared with the Caucasian sample.

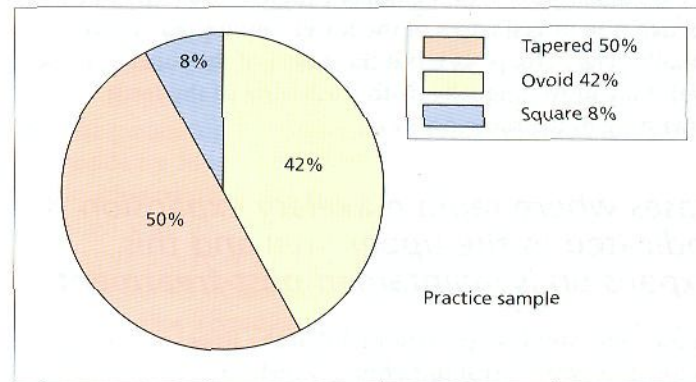


Fig. 4.1

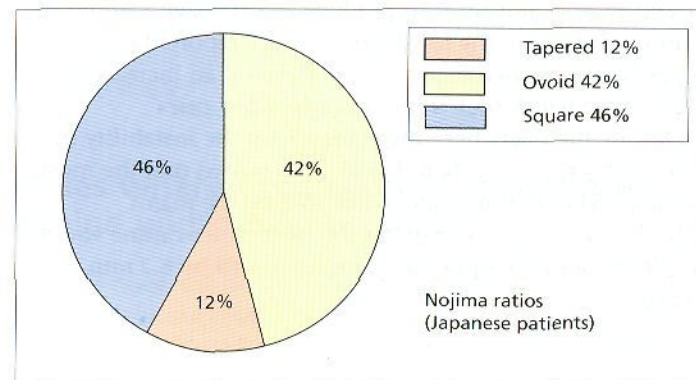


Fig. 4.2

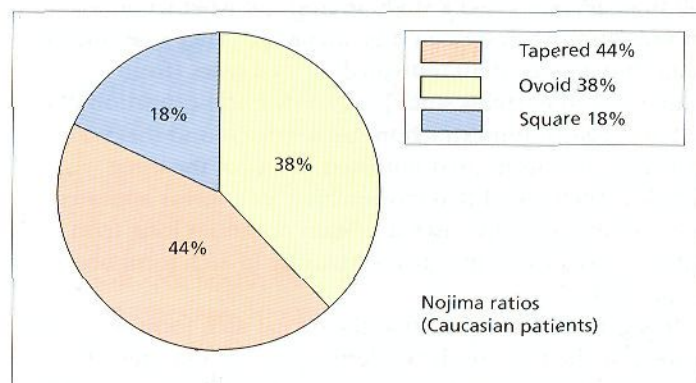


Fig. 4.3

Recommended ratios

It has been noted (p. 72) that two categories of cases do show post-treatment stability after minor lower arch buccal uprighiting. These are palatal expansion cases and deep-bite cases. Thus the recommended ratios (Fig. 4.4) of 45% tapered, 10% square, and 45% ovoid (p. 84) seem practical for a predominantly Caucasian practice.

The three shapes – tapered, square, and ovoid – used by the authors early in treatment are shown below (Figs 4.5–7). Later in treatment an individual arch form (IAF) is used for each patient (p. 78).

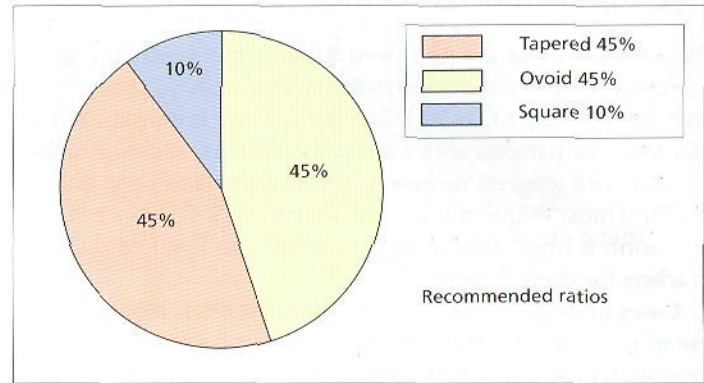


Fig. 4.4

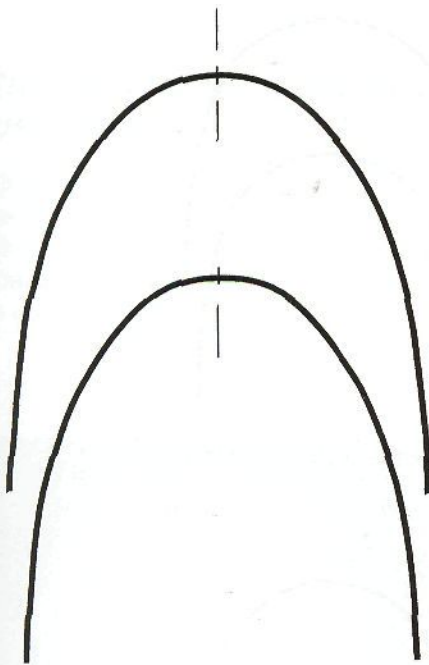


Fig. 4.5 Tapered

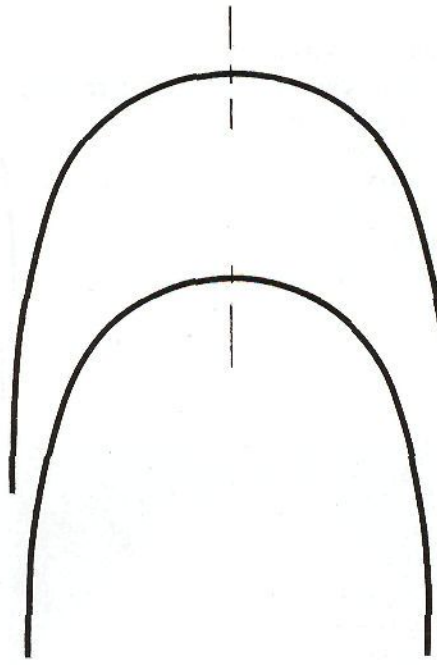


Fig. 4.6 Square

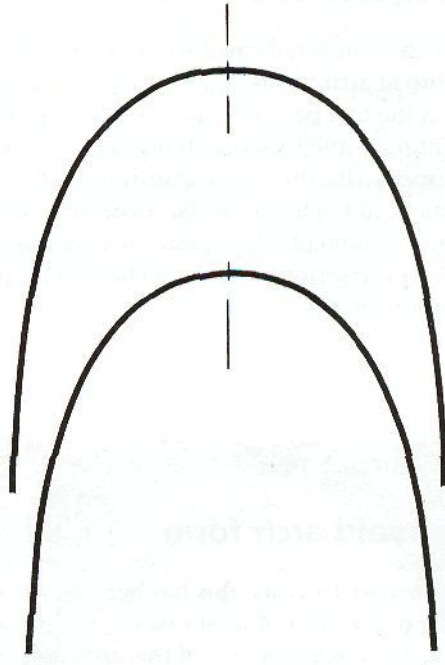
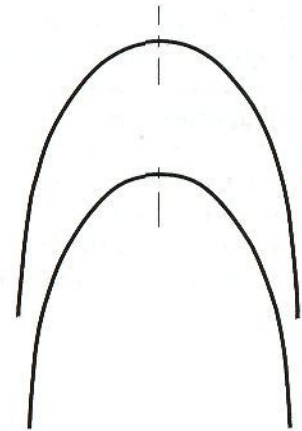


Fig. 4.7 Ovoid

The tapered arch form

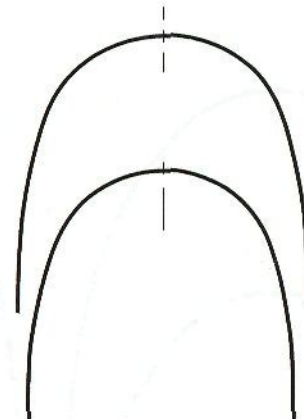
This arch form has the narrowest inter-canine width and is useful early in treatment for patients with narrow, tapered arch forms (Case AL, p. 86). It is particularly important to use this form for patients with narrow arch forms, and especially in cases with gingival recession in the canine and premolar regions (most frequently seen in adult cases). The tapered arch form is often used in combination with inverted canine brackets for these patients.

Cases undergoing single arch treatment often require the use of the tapered arch form. In this way, no expansion of the treated arch occurs, relative to the untreated arch. The posterior part of this arch form can easily be modified to match the inter-molar width of the patient.



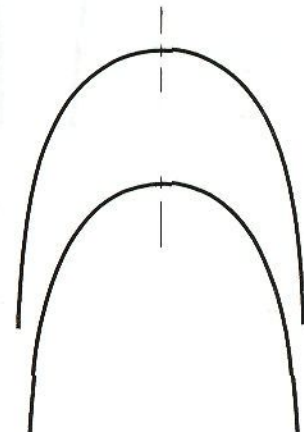
The square arch form

This arch form is indicated from the start of treatment in cases with broad arch forms (Case CW, p. 152). It is also helpful, at least in the first part of treatment, for cases that require buccal uprighting of the lower posterior segments and expansion of the upper arch. After overexpansion has been achieved, it may be beneficial to change to the ovoid arch form in the later stages of treatment. The square arch form is useful to maintain expansion in upper arches after rapid maxillary expansion (p. 80).



The ovoid arch form

Over the past 15 years, this has been the authors' preferred arch form for most of their cases,¹⁷ for example, Case JN, p. 120. The combined use of this arch form with appropriate finishing, settling, and retention procedures (p. 289) has resulted in a majority of cases with good stability, and minimal amounts of post-treatment relapse. However, the recent research (above) indicates that a greater number of tapered arch forms should also be used. When superimposed, the three shapes vary mainly in inter-canine and inter-first-premolar width, giving a range of approximately 6 mm (Figs 4.8 & 9) in this area.



SYSTEMIZED MANAGEMENT OF ARCH FORM

Standardized versus customized wires

It is not practical to customize every wire for every patient in a modern orthodontic practice, and it is not necessary if the system described below is used.

Multistrand .015 or round HANT .016 wires are used early in treatment as the initial leveling and aligning archwires, and these exert light forces. Their form is often temporarily distorted, due to tying into malaligned teeth. They can be expected to have little influence on arch form for the short periods that they are used. It is therefore reasonable to use a standard ovoid arch form for these early wires.

As the teeth align, and the treatment progresses into heavier HANT and then steel wires, archwires gradually have more effect on arch form. This is because of their greater tensile strength and the fact that they are used for a longer period of time. It is therefore beneficial, later in treatment, to customize wires to an arch form suitable for each individual patient.

The use of clear templates at the start of treatment

Clear templates can be used to assess the patient's lower model at the start of treatment, to determine whether the lower arch has a tapered, square, or ovoid form (Fig. 4.10). Often there will only be an approximate fit at this stage, but it is useful to have an early indication.

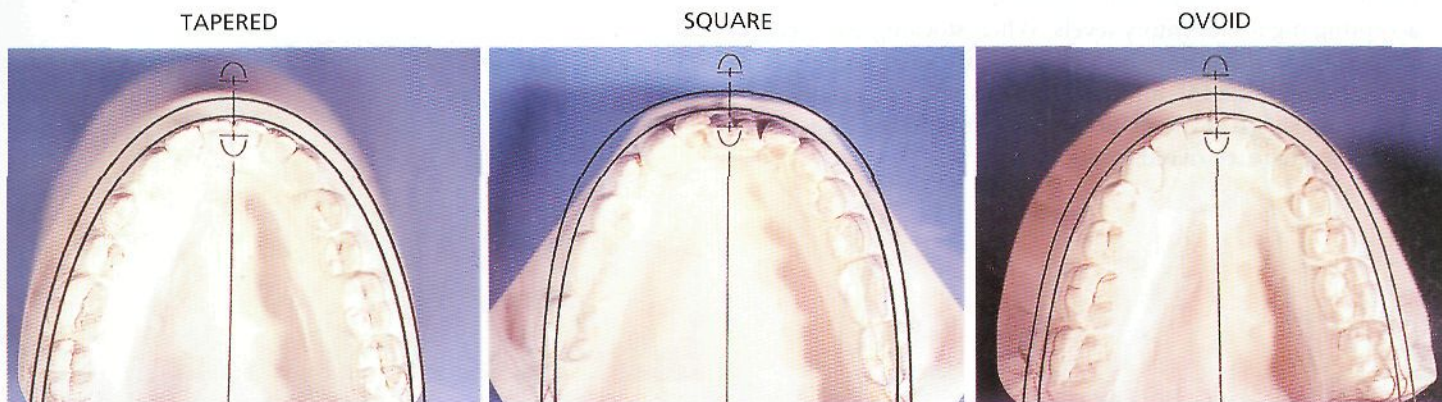


Fig. 4.10 Clear templates may be used at the start of treatment to assess whether the patient's lower arch has a tapered, square or ovoid form.

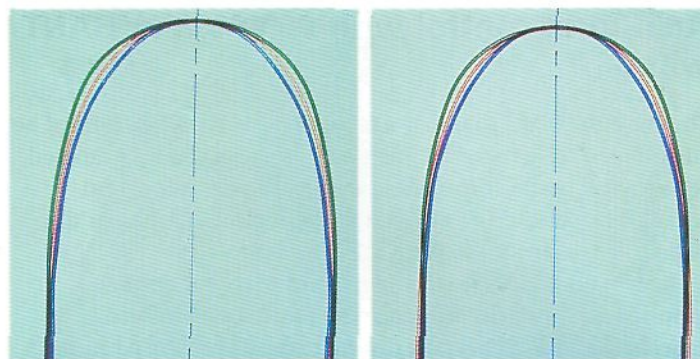


Fig. 4.8 Upper arch form superimpositions.

Fig 4.9 Lower arch form superimposition.

Arch form control early in treatment

It is recommended that all round wires be stocked in ovoid form only (p. 84). This helps to limit inventory. The opening wires will normally be .015 or .0175 multistrand, .016 HANT, or sometimes .014 steel. These may all be used in ovoid form, with no customizing.

As leveling and aligning progress into heavier round wires (pp 111 & 112), there will be a need to customize some wires. Consequently, the ovoid .016, .018, and .020 round steel wires should be adapted as necessary for individuals with a tapered or square form at the start of treatment, as previously determined using the clear templates. Archwire adaptation will obviously not be needed at this stage for individuals with an ovoid starting arch form.

Arch form control with rectangular HANT wires

The manufactured shape of rectangular HANT wires cannot be customized. It is therefore necessary to stock them in tapered, square, and ovoid form, because (like the heavier round wires) they should be used in the approximate form for the patient, as determined using the clear templates.

Rectangular HANT wires may be in place for several months, and they do influence the patient's arch form, especially in the important canine region. If not used in the appropriate tapered, square, or ovoid shape, they can cause undesirable changes in the patient's starting arch form.

Arch form control with rectangular steel wires

Rectangular steel .019/.025 working wires have a major influence on arch form. They therefore need to be customized to each patient's individual arch form (IAF). It is straightforward and quick to adapt working wires to the IAF, and shaping can be delegated and then finally checked by the orthodontist. Concerning stock control of .019/.025 steel wires (p. 84), there are three possibilities:

1. To stock ovoid shape only, and modify as necessary.
2. To stock ovoid and tapered shapes, which will reduce the amount of wire modification needed. This is a good option if the caseload includes mainly children, where the square arch form is seldom used.
3. To stock ovoid, square, and tapered shapes, and thus minimize the amount of wire adaptation needed, while accepting higher inventory levels. When stocking all three shapes, there will always be a need to customize some wires, because the IAF for many patients will not exactly match the shape of the manufactured wires in the basic tapered, square, or ovoid forms.

Customizing steel rectangular wires – determining the IAF for each patient

After the rectangular HANT wires have served their purpose, a .019/.025 stainless steel archwire can be individualized for each patient, based on the form of the lower dentition. An upper form can then be made which is coordinated with the lower, and 3 mm wider in all areas. The following procedure (Fig. 4.11 A–F) is used:

- After the rectangular HANT stage (Fig. 4.11A), a wax template is molded over the lower arch to record the indentations of the brackets (Fig. 4.11B).
- The .019/.025 stainless steel archwire is bent to the indentations in the wax bite (Fig. 4.11D).
- The wire is then compared with the starting lower model, or a Xerox copy of the model, to ensure that it closely resembles the overall starting shape.
- The wire is then checked for symmetry on a template.
- Finally, a Xerox copy of the wire is made and stored in the patient notes. This is the patient's IAF. Lower rectangular steel wires are then used in the IAF shape and uppers in a form which is 3 mm wider. Archwire coordination is important throughout treatment, especially with the heavier round wires and the .019/.025 rectangular stainless steel wires. The upper wire should superimpose approximately 3 mm outside of the lower wire. This is representative of the overlap of the upper teeth relative to the lower teeth, and provides for correct archwire coordination in the majority of cases (Fig. 4.11F).

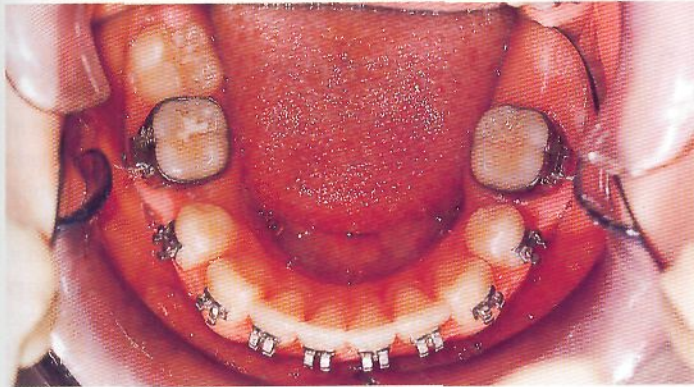


Fig. 4.11A The lower rectangular HANT wire has been removed.

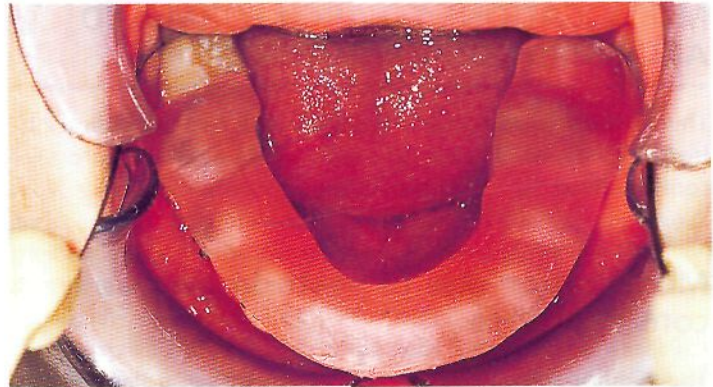


Fig. 4.11B A wax template is softened in warm water and molded over the lower arch to record indentations of the brackets.

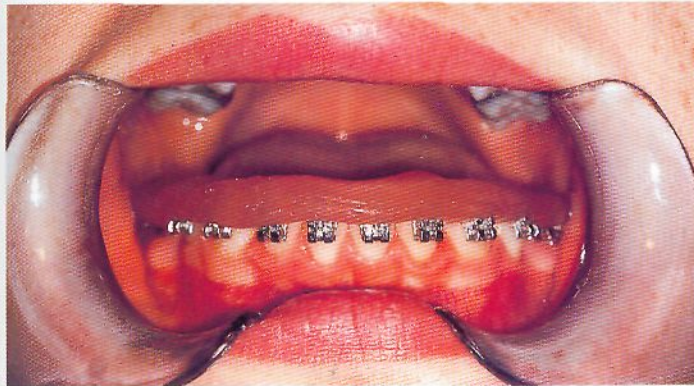


Fig. 4.11C The wax template viewed from the labial.



Fig. 4.11D The .019/.025 rectangular steel wire is bent to the indentations.

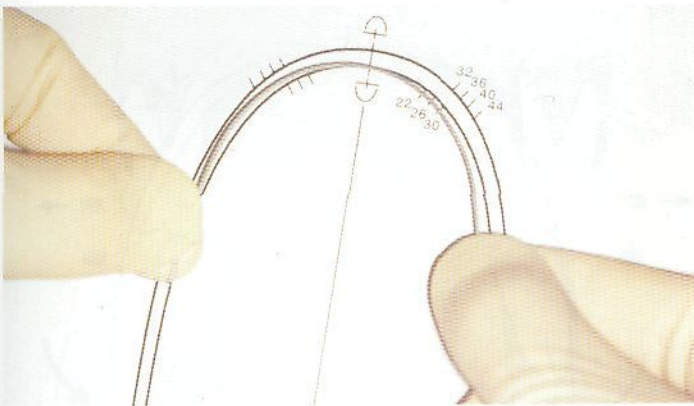


Fig. 4.11E The steel rectangular wire is checked for symmetry on a template, and then a Xerox copy can be made and used as the patient's IAF for the lower arch.

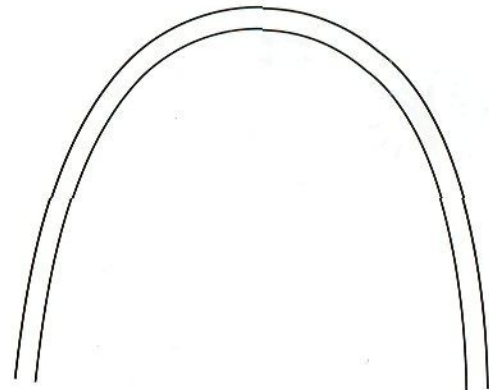


Fig. 4.11F After the patient's IAF has been determined for the lower archwire, an upper wire can be created which should superimpose approximately 3 mm outside of the lower wire.

MODIFICATIONS TO ARCH FORM AND ARCHWIRE COORDINATION

There are some cases that will require arch form modification from the normal IAF and the usual upper/lower archwire coordination.

Modification due to posterior torque considerations

The additional buccal root torque in the upper molar brackets tends to narrow the upper arch, and the progressive buccal crown torque in the lower posterior brackets tends to upright the lower molar teeth and widen the lower arch (Fig. 4.12). The combined effect of these appliance features can be a tendency towards molar crossbite in some cases. When this is observed, the posterior segment of the upper archwire can be widened to 5 mm wider than the lower archwire in the molar regions.

Modification after maxillary expansion

After the upper arch has been expanded with a rapid maxillary expander or a quadhelix (Fig. 4.13A), two things can occur. First, the lower arch tends to upright buccally, and second, the upper arch tends to relapse (Fig. 4.13B). To manage these effects, the lower arch can be widened by using a wider arch form (usually one size wider – for example from tapered to ovoid) and the upper arch expansion can be held with a correspondingly wider arch form.

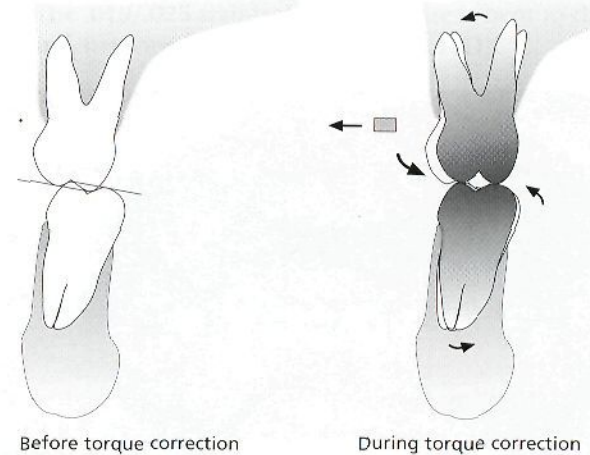


Fig. 4.12 During correction of molar torque, there is a tendency for a buccal crossbite to develop. If this is observed, it is necessary to widen the posterior segment of the upper archwire.

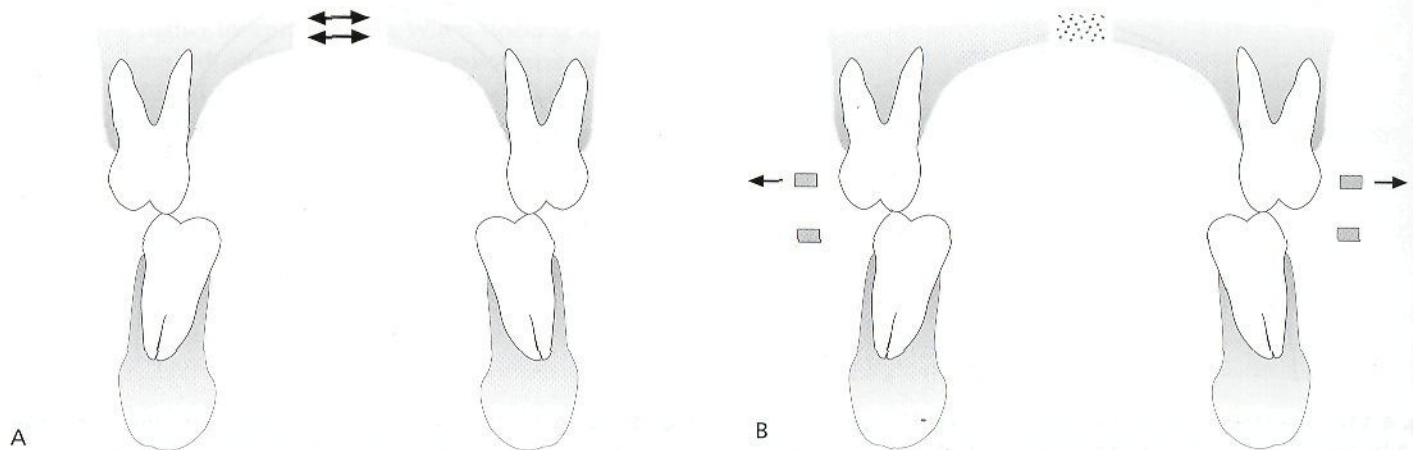


Fig. 4.13 After upper arch expansion (A), it is often necessary to widen the upper arch form and narrow the lower arch form (B) to counteract unwanted molar changes.

Upper arch expansion with archwires

In some cases, arch form coordination requires special attention, due to one arch (usually the upper arch) being slightly smaller than the other arch. The rectangular .019/.025 steel wires can be used to help correct this condition and achieve some arch expansion (p. 108), or to maintain expansion previously obtained by use of a quadhelix or by rapid maxillary expansion. This may be done by expanding the IAF arch form in the molar regions, or by use of the square arch form for a limited period.

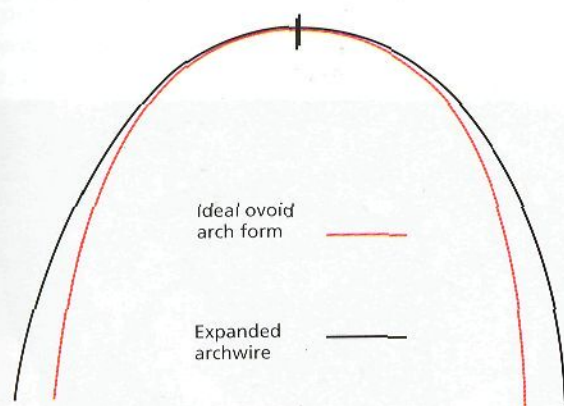


Fig. 4.14 It is important to use a correct technique for archwire expansion.

There is a correct technique for archwire expansion. If the wire is bent to expand its width (Fig. 4.14), it is important to make sure it is not overexpanded and thus distorted from the arch form. When the ends of the expanded wire are held, and pressed back towards the chosen arch form (IAF), the wire should match that shape (Fig. 4.15). If overexpanded or incorrectly expanded (Figs 4.16 & 4.17), it will not match the chosen arch form (IAF) when the ends are pressed towards it, and this will cause problems due to narrowing or widening of the inter-canine width.

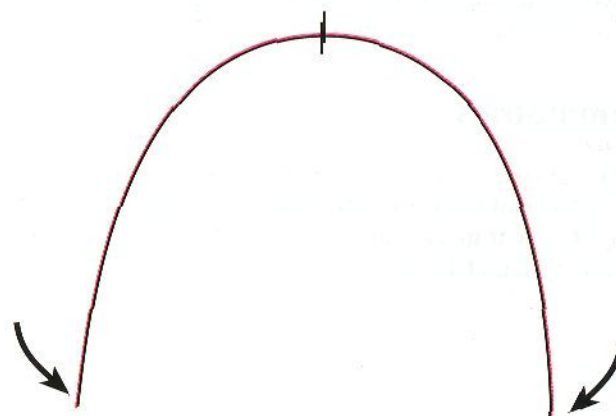


Fig. 4.15 After correct expansion, if the ends of the archwire are pressed towards the ideal arch, the expanded arch will show correct form.

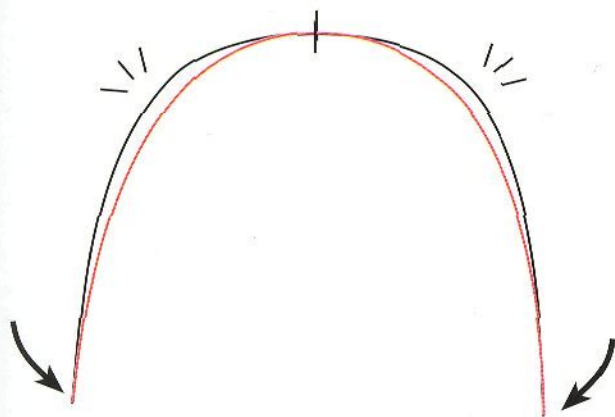


Fig. 4.16 Incorrect expansion.

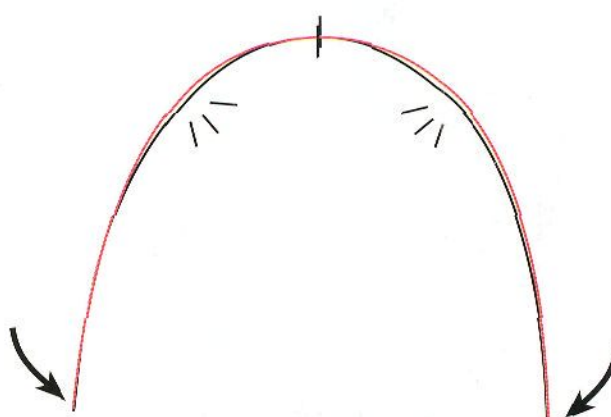


Fig. 4.17 Incorrect expansion.

Upper arch expansion with a jockey wire

There are limits to the expansion force which can be delivered by one .019/.025 rectangular wire during routine treatment. If necessary, particularly near the end of treatment, a little more expansion force can be achieved by using a 'jockey arch' (Case MS, pp 238 & 239). This is merely a second archwire, also expanded, tied in place over the normal archwire (Fig. 4.18). The jockey arch may be of .019/.025 rectangular steel, or of heavier round steel wire. If the upper first molars carry headgear tubes, it can be convenient to end the jockey archwire in those tubes.

It is helpful if the normal .019/.025 wire has buccal root torque in the molar region (Fig. 5.30, p. 108) to attempt bodily movement of molars and avoid tipping. It is important to have adequate bone width to achieve upper molar expansion (Fig. 10.15, p. 290).

Asymmetries

In cases where it is clear that the patient has an arch asymmetry, and there are many such cases, the archwires later in the treatment may be modified to assist correction of the asymmetry (Figs 4.19–21).

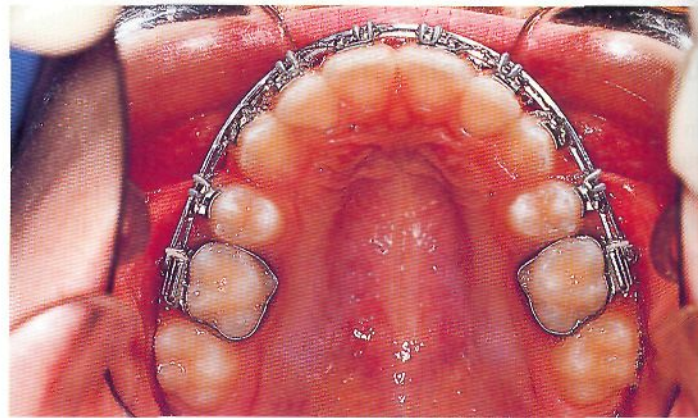


Fig. 4.18 Occlusal view of a 'jockey arch' in place. This may be of .019/.025 rectangular steel wire or of heavier round steel wire.

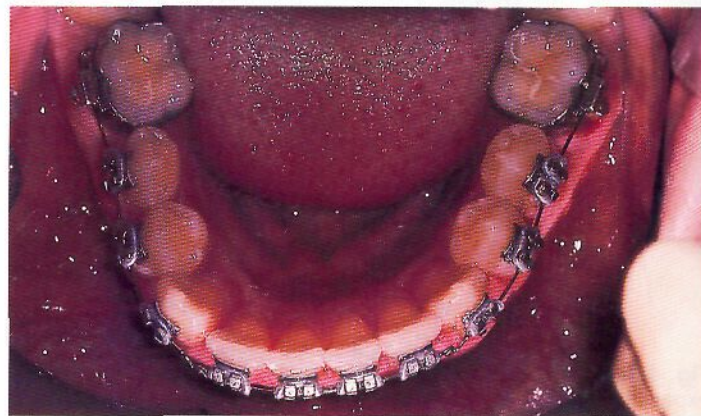


Fig. 4.19 Occlusal view of an asymmetrical lower arch.

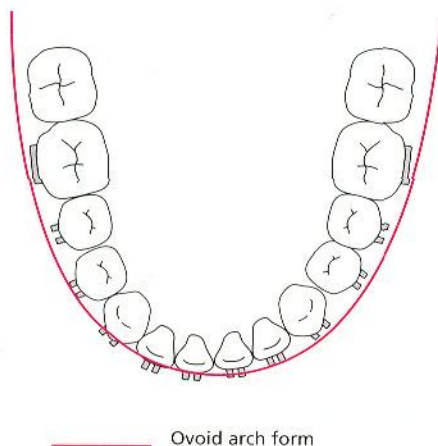


Fig. 4.20 Asymmetry of the lower arch in Figure 4.19, compared with the ovoid lower arch form.

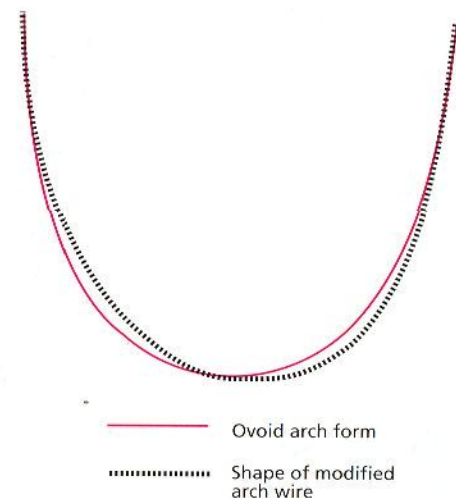


Fig. 4.21 Modification of the lower archwire to counteract and correct the dental asymmetry in Figure 4.19.

ARCH FORM DURING FINISHING AND DETAILING – THE NEED FOR SETTLING

There are important arch form considerations during the closing stages of any treatment. A careful protocol allows the arch form to settle in the later stages of treatment. A settling phase is required in almost every case. The following steps are recommended:

- Patients should not progress directly from rectangular wires to retainers without a phase of settling in lighter wires. The authors prefer a full .014 stainless steel or .016 nickel-titanium lower archwire, and an upper .014 stainless steel sectional wire, to include only the upper incisors, in combination with light triangular elastics, near the completion of treatment. The patient is checked at 2-weekly intervals for approximately 6 weeks (Case JN, p. 124, and Case MOT, p. 274). During this period, vertical tooth settling occurs and the upper and lower arch forms are also allowed to settle, so that a balance between the tongue and perioral musculature can re-establish.
- During this settling phase, teeth adjacent to extraction sites should be lightly tied together, to prevent space opening.
- If the maxillary arch has been expanded earlier in the treatment, the expansion needs to be held during the settling phase. An upper removable acrylic plate may be used for this (Fig. 10.22, p. 295).

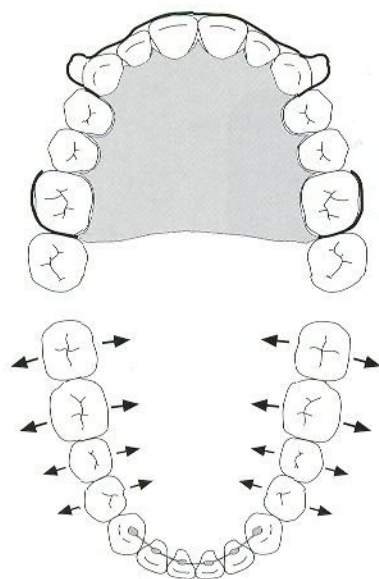


Fig. 4.22 During retention, the upper teeth are held, but lower molars and premolars can move labio-lingually.

- In Class II treatments (where overjet relapse may occur during settling), a full .014 upper archwire is necessary, bent back behind the molars (Case DO, p. 210). This may slow the settling, but it is needed to hold the corrected overjet. Some second-order bends can be placed in this wire to encourage proper settling.

ARCH FORM CONSIDERATIONS DURING RETENTION

There is a constant tendency for lower incisor relapse in the majority of cases. Lower bonded retainers from canine to canine (p. 307) are recommended to minimize this tendency. In first premolar extraction cases, the bonded retainer may be extended onto the second premolars. Typically, a patient in retention will have a lower bonded retainer and an upper acrylic removable retainer. The lower premolars and molars are thus free to narrow, relative to the fully retained upper arch (Fig. 4.22). It may be necessary to modify or leave out the upper acrylic retainer for 2 to 4 weeks, to let the upper premolars and molars adjust to lower arch changes (Fig. 4.23). A new acrylic retainer can then be made. If a vacuum-formed upper retainer is used, it may be modified for 2 to 4 weeks and then re-made.

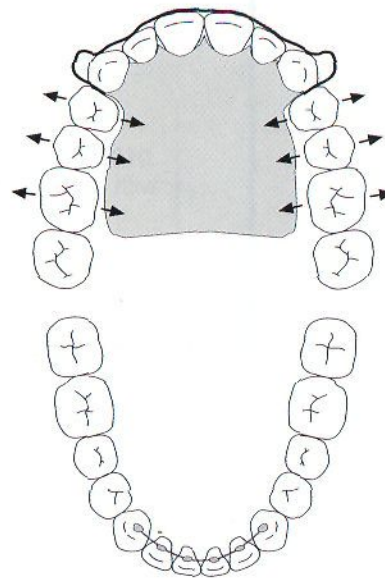


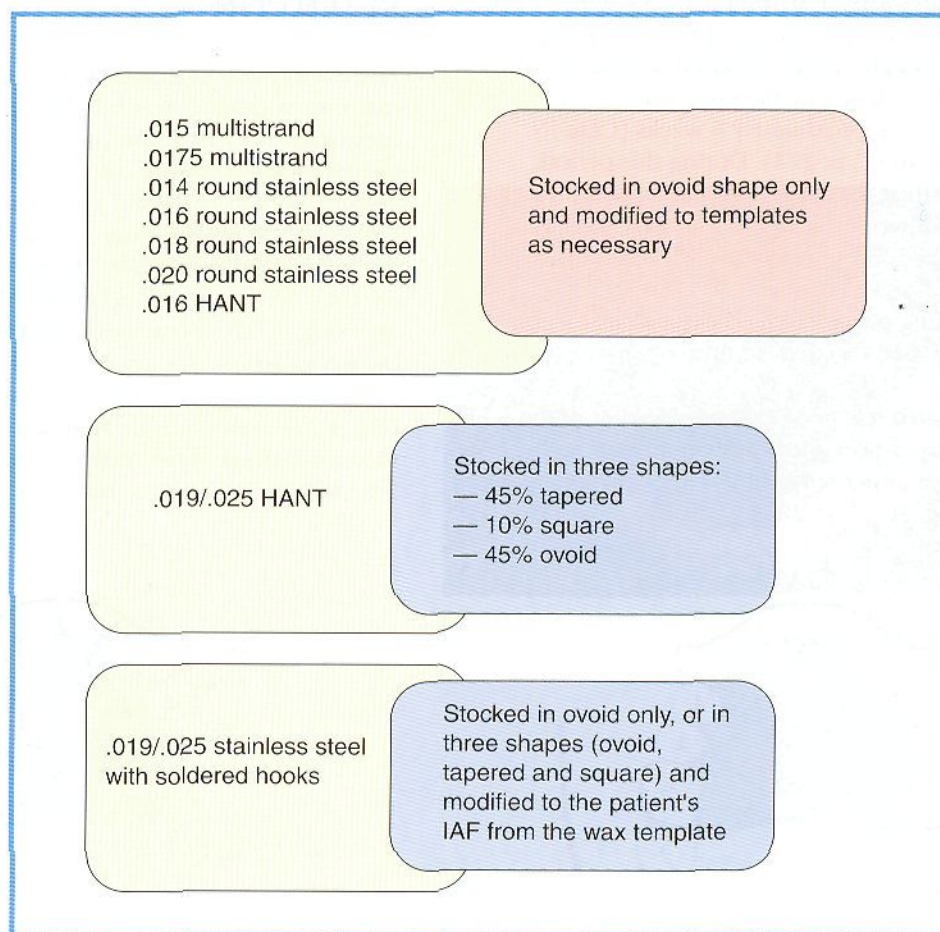
Fig. 4.23 The upper acrylic retainer may be omitted or modified for 2 to 4 weeks to let upper molars and premolars adjust to lower changes. A new upper removable retainer can then be made and fitted.

STOCK CONTROL PROTOCOL FOR ARCHWIRES

An example of a suitable stock system is shown below. It is possible to stock steel working wires in one, two, or three shapes, depending on the size of the practice and the desire to minimize wire modification.

Customization of archwires reduces the risk of relapse and helps to achieve good esthetics. If a broad arch form is used for an individual with a narrow facial appearance, for

example, there will be a risk of relapse and an unnatural look to the smile. It is therefore desirable for the clinical orthodontist to have a system of customizing the arch form for each patient, but without having to overstock practice inventory or spend time with needless wire bending. This chapter has described a system which the authors use and recommend with confidence.



REFERENCES

- 1 Hawley C A 1905 Determination of the normal arch and its application to orthodontia. *Dental Cosmos* 47:541-552
- 2 Scott J H 1957 The shape of the dental arches. *Journal of Dental Research* 36:996-1003
- 3 Brader A C 1972 Dental arch form related to intra-oral forces. *American Journal of Orthodontics* 61:541-561
- 4 McLaughlin R P, Bennett J C 1999 Arch form considerations for stability and esthetics. *Revista Espana Ortodontica* 29(2):46-63
- 5 Riedel R A 1969 In: Graber T M (ed) *Current orthodontic concepts and techniques*. Saunders, Philadelphia
- 6 De La Cruz A R, Sampson P, Little R M, Artun J, Shapiro P A 1995 Long-term changes in arch form after orthodontic treatment and retention. *American Journal of Orthodontics* 107:518-530
- 7 Burke S P, Silveira A M, Goldsmith L J, Yancey J M, Van Stewart A, Scarfe WC 1998 A meta-analysis of mandibular intercanine width in treatment and post retention. *Angle Orthodontist* 68(1):53-60
- 8 Felton M J, Sinclair P M, Jones D L, Alexander R G 1987 A computerized analysis of the shape and stability of mandibular arch form. *American Journal of Orthodontics* 92:478-483
- 9 Shapiro P A 1974 Mandibular arch form and dimension. *American Journal of Orthodontics* 66:58-70
- 10 Ladner P T, Muhl Z F 1995 Changes concurrent with orthodontic treatment when maxillary expansion is a primary goal. *American Journal of Orthodontics and Dentofacial Orthopedics* 108:184-193
- 11 Sandstrom R A, Klapper L, Papaconstantinou S 1988 Expansion of the lower arch concurrent with rapid maxillary expansion. *American Journal of Orthodontics* 94:296-302
- 12 Haas A J 1980 Long-term posttreatment evaluation of rapid palatal expansion. *Angle Orthodontist* 50:189-217
- 13 Braun S, Hnat W P, Fender D E, Legan H L 1998 The form of the human dental arch. *Angle Orthodontist* 68(1):29-36
- 14 Braun S, Hnat W P, Leschinsky R, Legan H L 1999 An evaluation of the shape of some popular nickel titanium alloy preformed arch wires. *American Journal of Orthodontics and Dentofacial Orthopedics* 116:1-12
- 15 Chuck G C 1934 Ideal arch form. *Angle Orthodontist* 4:312-327
- 16 Nojima K, McLaughlin R P, Isshiki Y, Sinclair P M 2001 A comparative study on Caucasian and Japanese mandibular clinical arch forms. *Angle Orthodontist* 71:195-200
- 17 Bennett J, McLaughlin R P 1993 *Orthodontic treatment mechanics and the preadjusted appliance*. Mosby-Wolfe, London (ISBN 0 7235 1906X)

CASE AL

The following case shows an example of a patient with a tapered arch form and prominent canine roots at the start of treatment.

This 15.5-year-old female patient was Class I skeletally, with a high-angle vertical pattern. From the frontal aspect, she had a narrow facial appearance, with some mandibular asymmetry to the left. Lower incisors were retroclined at 78° to the mandibular plane to the mandibular plane and at APo -1mm . The facial profile was pleasing and harmonious.

Dentally, the patient was Class I in the buccal segments. The centric occlusion and centric relation were coincident, with no displacements at terminal closure. There was mild crowding of the upper and lower incisor regions, and notable prominence of the canine roots. Upper and lower midlines were coincident. There was a small amount of enamel damage to the incisal edge of the upper right central incisor.

The facial appearance was reflected in the arch form, which was narrow and tapered. There were extensive, but not deep, restorations in first and second molars. There was a lack of space for the third molars, with impactions on the left side, and a supplemental upper left third molar. It was decided to extract all the third molars. The mild crowding would be resolved by torqueing and uprighting of the buccal segments and slight proclination in the lower incisor region. The selected arch form would be tapered, which would maintain the basic form of the patient's dental arches.

Standard .022 metal brackets were placed. The upper and lower canine brackets were inverted, to maintain the canine roots in bone. All the teeth, including second molars, were banded or bracketed. The opening wires were .016 HANT to an ovoid arch form.



Fig. 4.24



Fig. 4.27

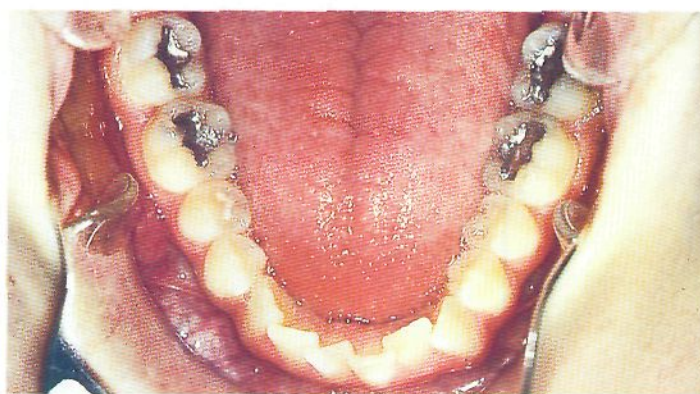


Fig. 4.30

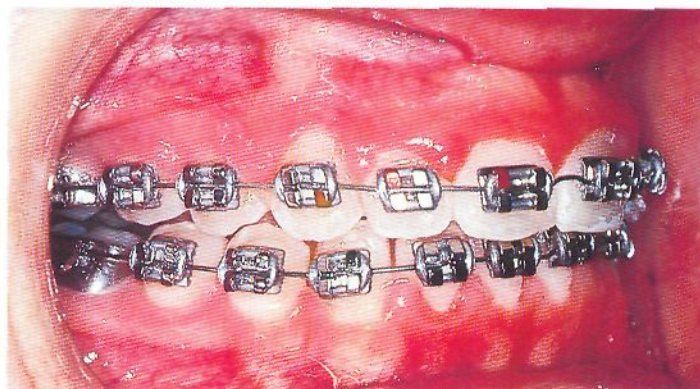
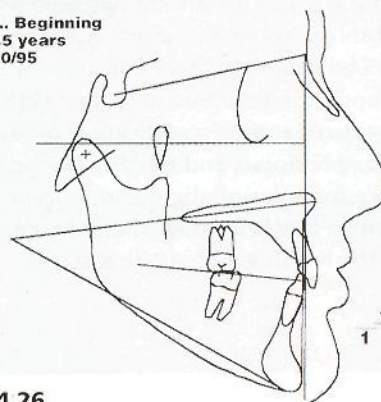


Fig. 4.33



Fig. 4.25

A.L. Beginning
15.5 years
9/20/95



SNA $\angle$ 77°
SNB $\angle$ 75°
ANB $\angle$ 2°
A-N FH -1 mm
Po-N FH -1 mm
WITS 0 mm
GoGnSN $\angle$ 42°
FM $\angle$ 30°
MM $\angle$ 37°
1 to A-Po 4 mm
1 to A-Po -1 mm
1 to Max Plane $\angle$ 101°
1 to Mand Plane $\angle$ 78°

Fig. 4.26



Fig. 4.28



Fig. 4.29

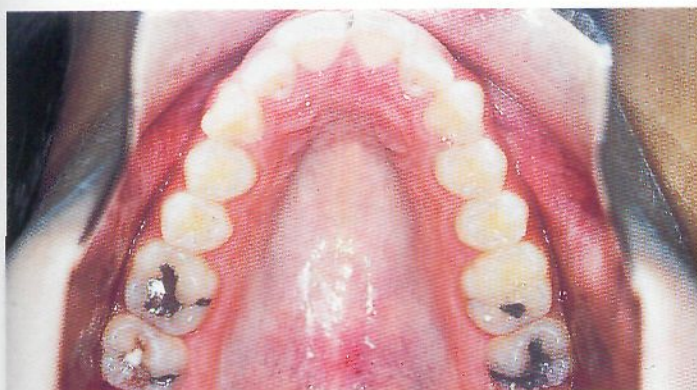


Fig. 4.31

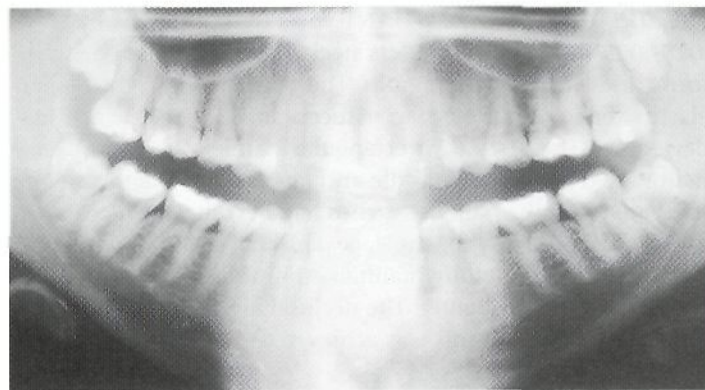


Fig. 4.32

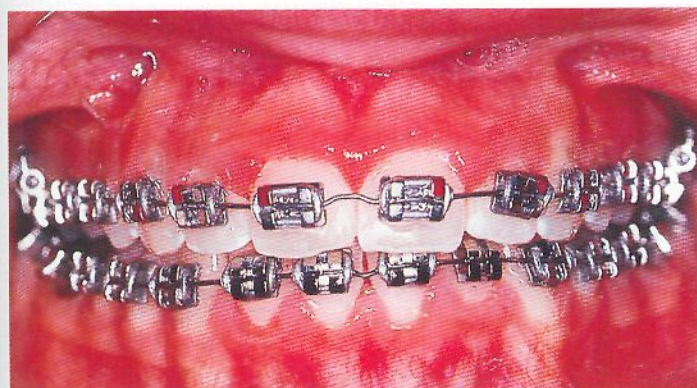


Fig. 4.34

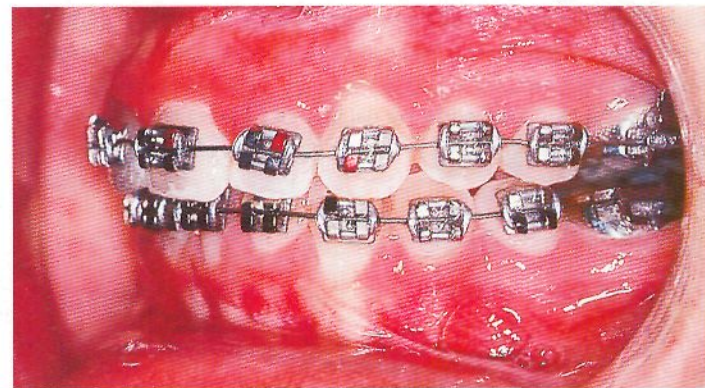


Fig. 4.35

The .016 HANT wires in the ovoid form were followed by .019/.025 rectangular HANT wires, with the selected tapered arch form. The .019/.025 rectangular HANT wires had the effect of torqueing and uprighting the buccal segments (Fig. 4.40) as a result of the reduced torque specification of the appliance system in lower premolars and molars. This in turn provided additional space for anterior alignment. The earlier decision to invert the canine brackets allowed good control of the canine roots during the leveling and aligning stages.

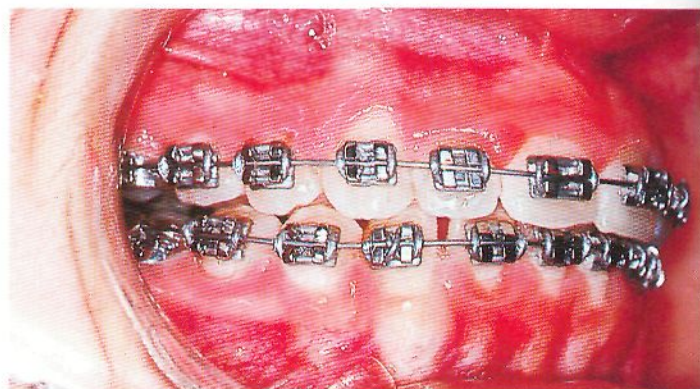


Fig. 4.36



Fig. 4.39

The .019/.025 rectangular HANT wires were followed by .019/.025 rectangular stainless steel wires, with tapered arch form, and with soldered hooks. The patient wore light Class II elastics for a short period, to reduce a small overjet which had developed. The .019/.025 rectangular stainless steel wires were maintained during the middle and later part of the treatment. It was felt that the patient's arches had become a little too ovoid during the alignment stage, and the .019/.025 stainless steel wires were carefully maintained in the tapered form, to narrow the arches slightly. The occlusal views at the end of treatment show that this was achieved.

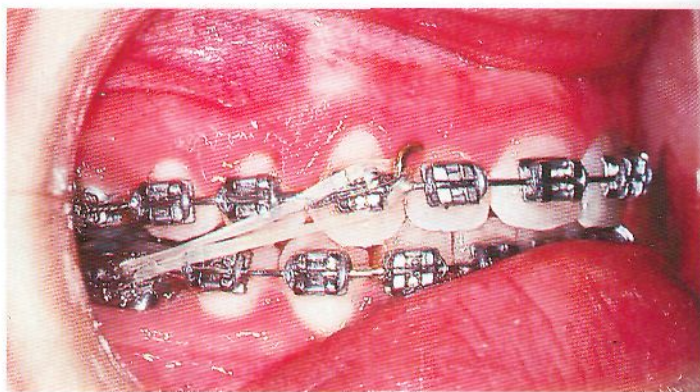


Fig. 4.42

Late in the treatment, the referring dentist requested enamel reshaping of the incisal edge of the upper right central incisor. This was followed by repositioning of the incisor bracket, and then re-leveling and aligning using a .014 steel wire. In the lower arch, a .016 HANT wire was used to commence settling of the case.



Fig. 4.45

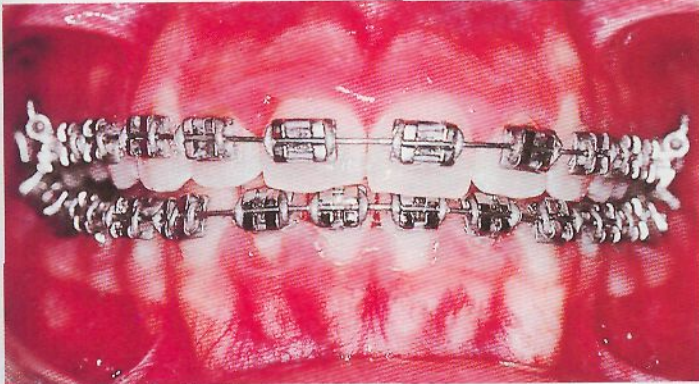


Fig. 4.37



Fig. 4.38

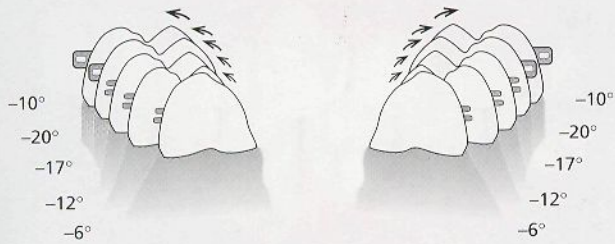


Fig. 4.40

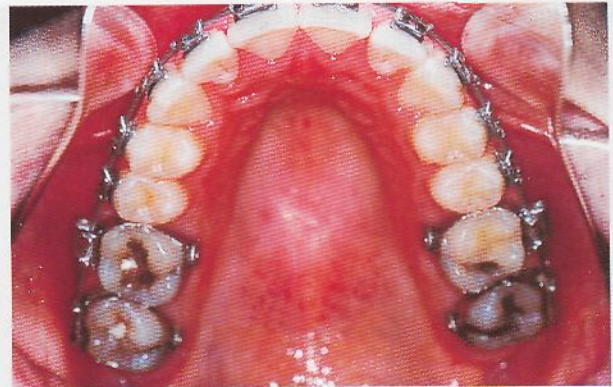


Fig. 4.41

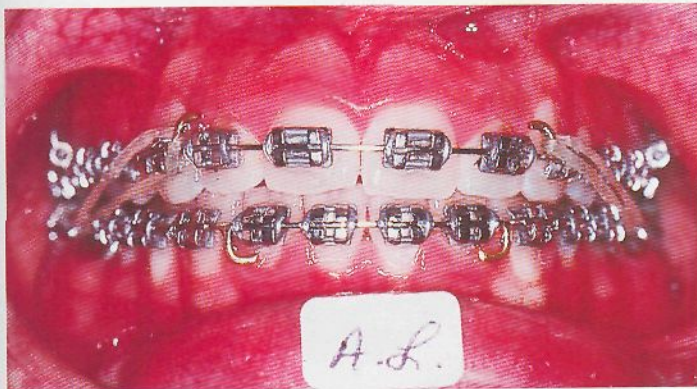


Fig. 4.43



Fig. 4.44



Fig. 4.46



Fig. 4.47

Selective up-and-down elastics were used with light wires during the settling stage. The light wires allowed settling of the arch form.

A pleasing dental result was achieved. The canine crown and root positions result from the bracket specifications used in this case. These were $+7^\circ$ torque and 8° tip in the upper, and $+6^\circ$ torque and 3° tip in the lower.

A lower bonded retainer and an upper removable retainer were used. The tapered arch form was suitable for this case because it relates to the patient's starting lower arch form and is appropriate for her narrow facial appearance. Early in the treatment the arch form became a little too ovoid, but the steel rectangular wires were successfully used to restore and maintain the tapered shape into the final result.

Facially, the patient was similar to the starting appearance, which was very satisfactory. Dentally, there was a change in angulation of the lower incisors, with 1mm of proclination towards APo, and this helped to resolve the lower anterior crowding.



Fig. 4.48



Fig. 4.51

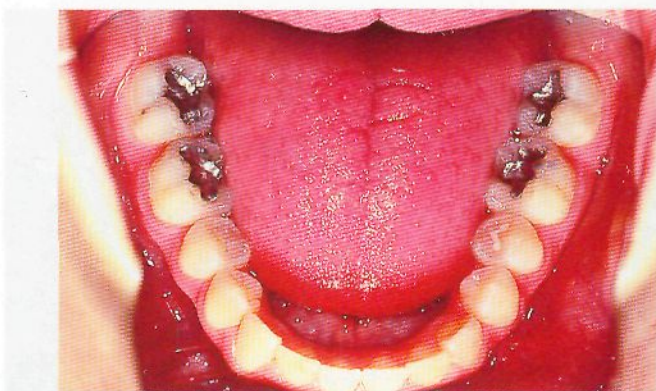


Fig. 4.54

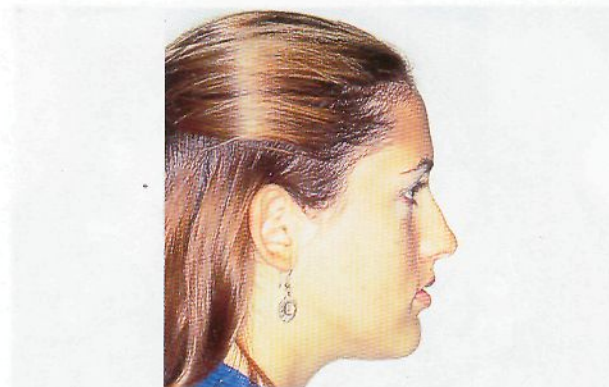


Fig. 4.57

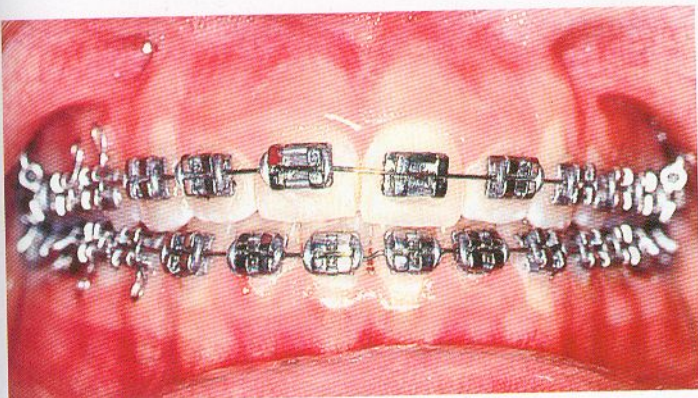


Fig. 4.49

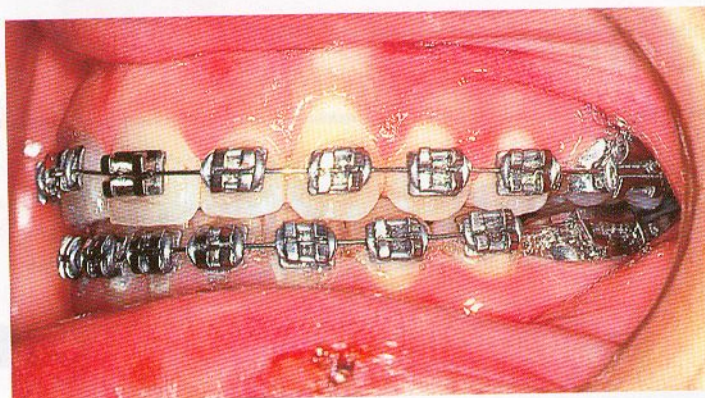


Fig. 4.50



Fig. 4.52



Fig. 4.53

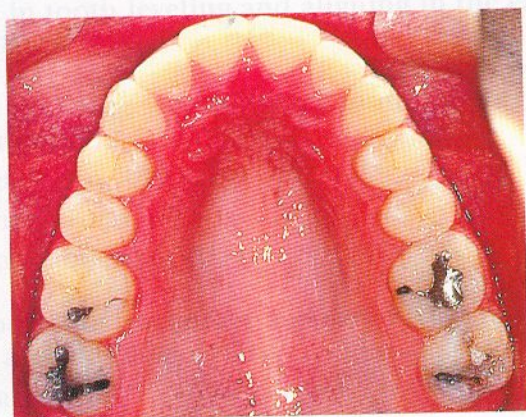


Fig. 4.55

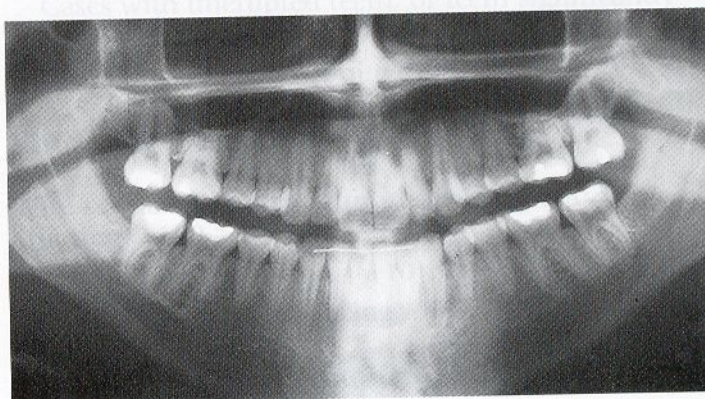


Fig. 4.56



Fig. 4.58

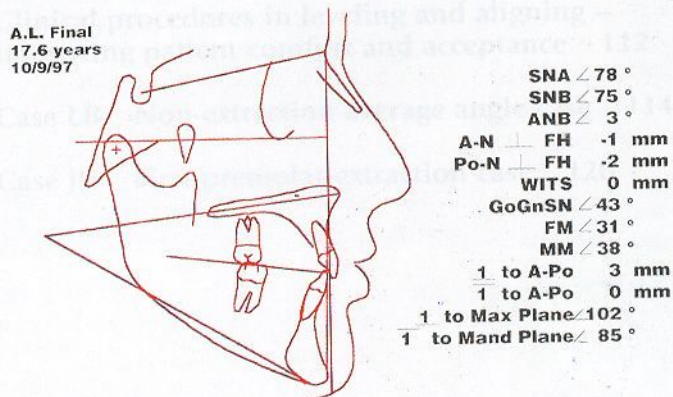


Fig. 4.59

CHAPTER 5

Anchorage control during tooth leveling and aligning

Introduction and definitions 94

- Short-term versus long-term objectives 94
- Principles of anchorage control 94
- Treatment sequence to show leveling and aligning 95

Recognizing the anchorage needs of a case 96

- Class II/1 example 96
- Class III example 97
- Bimaxillary protrusion example 97
- Bimaxillary retrusion – a Class II/2 example 97

Mistakes in tooth leveling and aligning in the early years 98

Reduced anchorage needs during tooth leveling and aligning 99

- Bracket design 99
- Archwire forces 99
- Avoidance of elastic chain 99

Antero-posterior anchorage support during tooth leveling and aligning 100

- Lacebacks for A/P canine control 100
- Bendbacks for A/P incisor control 102
- A/P anchorage control of lower molars – the lingual arch 104
- A/P anchorage control of lower molars – Class III elastics and headgear 104
- A/P anchorage support and control for upper molars – the use of headgear 105
- A/P anchorage support and control for upper molars – the palatal bar 106

Vertical anchorage control during tooth leveling and aligning 106

- Incisor vertical control 106
- Canine vertical control 107
- Molar vertical control in high-angle cases 107

Anchorage control in the lateral (coronal) plane 108

- Inter-canine width 108
- Molar crossbites 108

Exceptions to full bracket placement 109

- Cases with unerupted teeth, or teeth significantly out of the arch form 109
- Some high-angle deep-bite cases 109

Re-leveling procedures 109

Wire sequencing during tooth leveling and aligning 110

- Historical background 110
- Recommended sequencing 110

Heat-activated nickel-titanium or stainless steel? 111

Clinical procedures in leveling and aligning – improving patient comfort and acceptance 112

Case LB Non-extraction average angle case 114

Case JN First premolar extraction case 120

INTRODUCTION AND DEFINITIONS

Tooth leveling and aligning is normally the first orthodontic objective during the initial stage of treatment. It may be defined as:

The tooth movements needed to achieve passive engagement of a steel rectangular wire of .019/.025 dimension and of suitable arch form, into a correctly placed preadjusted .022 bracket system.

Successful tooth alignment depends on recognizing that unwanted tooth movements can occur early in treatment, mainly owing to the tip built in to the preadjusted brackets. These unwanted tooth movements need to be controlled, or the underlying malocclusion will worsen during tooth alignment. This will increase the time and effort needed to complete the case, later in treatment.

During leveling and aligning, therefore, all tooth movements should be carried out with the final treatment goal in mind, and anchorage control measures should be used to restrict unwanted tooth movements. In this text, the term 'anchorage control during tooth leveling and aligning' will have the following meaning:

The maneuvers used to restrict undesirable changes during the opening phase of treatment, so that leveling and aligning are achieved without key features of the malocclusion becoming worse.

Short-term versus long-term objectives

It is helpful to consider leveling and aligning against a background of short-term and long-term objectives:

- The short-term objectives, in the opening months of treatment, will be to achieve proper leveling and aligning into passive rectangular steel wires.
- The long-term objectives, to be reached by the end of treatment, will be to achieve an ideal dentition, showing the six keys to normal occlusion, and with the dentition properly positioned in the facial profile.

Experience has repeatedly shown that attempts to rush the short-term objectives, by taking short cuts and using heavy forces, cause unwanted changes to take place. These make achievement of the long-term objectives more time consuming and difficult.

Principles of anchorage control

There are two main aspects to anchorage control:

1. Reduction of anchorage needs during leveling and aligning. There is a need to minimize the factors which threaten anchorage and which produce unwanted tooth movements. This reduces the demands on anchorage.
2. Anchorage support during tooth leveling and aligning. Where necessary, there is a need to use anchorage support, such as palatal or lingual bars, to help to control certain teeth, or groups of teeth.

Anchorage control needs will differ from case to case. Measures to support anchorage control will not be needed in both arches, in every case. In some cases, for example in some Class I and Class II/2 cases, no special measures will be required, and tooth alignment can proceed without regard to anchorage control. However, most cases do require proper anchorage control, and it is important to identify the needs for each individual case.

Treatment sequence to show leveling and aligning



Fig. 5.1A In this very crowded Class I case, the first premolars had previously been extracted. The upper right lateral incisor was in crossbite, and there was 2 mm of displacement at terminal closure.



Fig. 5.1B Initial alignment was commenced with a .015 multistrand upper archwire and a .016 HANT lower archwire. A band with an eyelet was placed on the upper right lateral incisor. This was loosely tied.



Fig. 5.1C Two months later. The upper right lateral incisor bracket was not inverted because the root position of this tooth was good, and special torque control was not required. A multistrand wire was used to continue tooth leveling and aligning in the upper, with a .014 round steel wire in the lower.

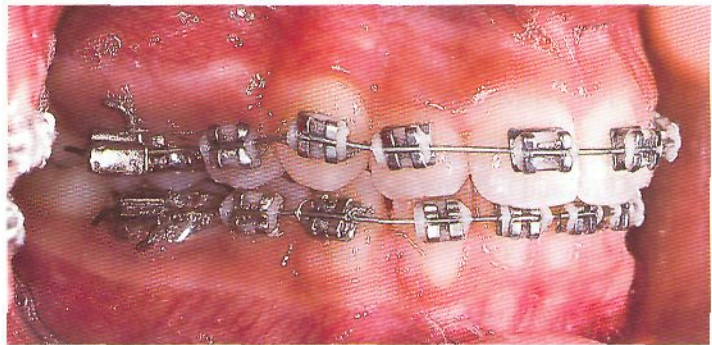


Fig. 5.1D After 4 months of treatment, it was possible to place upper and lower rectangular .019/.025 HANT wires. These very effective wires were used for several months, changing elastomeric modules and re-tying as necessary.



Fig. 5.1E Here the case is seen at completion of tooth leveling and aligning. Steel rectangular wires, .019/.025 in dimension and of ovoid arch form, are passively engaged in a correctly placed preadjusted .022 bracket system.



Fig. 5.1F The case after settling and appliance removal. Good tooth fit was assisted by the large size of the upper lateral incisors.

RECOGNIZING THE ANCHORAGE NEEDS OF A CASE

At the diagnosis and treatment planning stage for each case, a goal will be set for incisor position in the facial complex at the end of treatment. The determination of this 'planned incisor position' or PIP is explained on pages 166 to 169. The planned molar and canine changes will have been determined using the dental VTO.¹

The anchorage control needs of a case, early in treatment, can be decided by comparing the starting position of upper and lower incisors with PIP at the end of treatment. During tooth leveling and aligning, the anchorage control should be managed to ensure that the upper and lower incisors either show no change, or they should move favorably relative to PIP. Ideally, incisor movement should be favorable, relative to PIP, throughout leveling and aligning, thereby reducing the amount of tooth movement needed later in the treatment.

Class II/1 example

At the start of treatment, the upper incisors are normally in front of PIP, and full A/P anchorage control will be required to restrict mesial movement and an increase in overjet. As discussed later in this chapter, upper arch anchorage control will involve lacebacks and bendbacks, and may require support from a palatal bar, a headgear, or Class II elastics.

Lower incisors will normally be on or behind PIP. Anchorage will need to be managed to prevent undue proclination during alignment. As with most cases, care will be needed to avoid excessive archwire forces, to eliminate the risk of a 'roller coaster' effect and deepening of the overbite.

Most of the concern will be with A/P changes, but torque control and vertical issues need to be considered and properly managed, where appropriate.

Anchorage needs for the molars and canines can be predicted from the dental VTO. These teeth should show no change, or preferably favorable change, relative to the VTO requirements.

In the following examples, the incisor starting position is shown in black, with the PIP in green, and comments are offered concerning the likely needs of the case. Every orthodontic case will be different, and the anchorage control needs will be determined by the position of the incisors relative to PIP, and not by the Angle's classification of the molars.

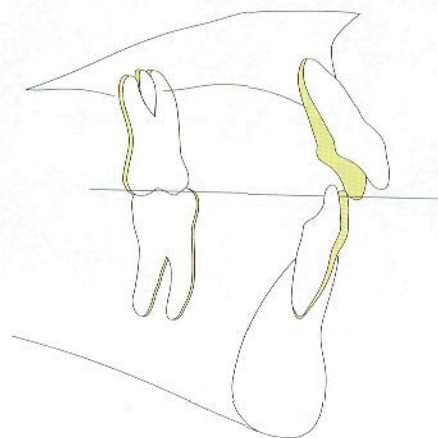


Fig. 5.2 Class II/1

Class III example

In this example, the upper incisors are behind PIP at the start of treatment, although in other Class III cases they may be on PIP or even in front of it. Lacebacks and bendbacks will therefore be contraindicated in the upper arch in many Class III cases, to allow upper incisors to procline and show favorable torque changes towards PIP, and to allow upper arch development.

Anchorage control will only be needed if there is a risk of overproclination of the upper incisors, beyond the PIP.

Lower incisors will typically be in front of PIP in a Class III case. The lower arch will therefore normally require full anchorage control with bendbacks and lacebacks, possibly supported with a lingual arch and/or Class III elastics.

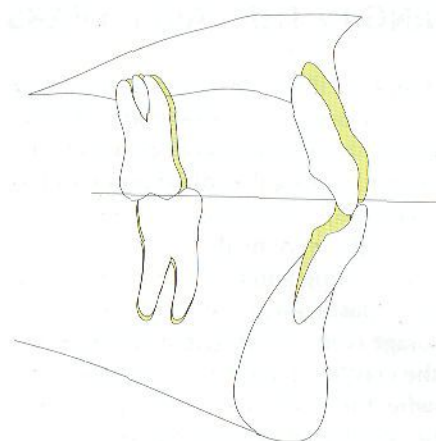


Fig. 5.3 Class III

Bimaxillary protrusion example

Normally full anchorage control will be required in both arches for this type of case, because upper and lower incisors will be in front of PIP at the start of treatment.

Interestingly, the mesializing effect of bracket tip often does not come into play in these cases, because the crowns are tipped mesially at the start. Despite this, full anchorage control is normally appropriate in the early stages, to ensure optimal retraction of the anterior segments.

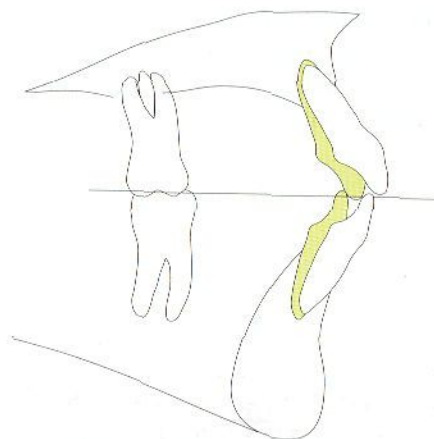


Fig. 5.4 Bimaxillary protrusion

Bimaxillary retrusion – a Class II/2 example

In these cases, it is often a treatment requirement to allow upper and lower incisors unrestricted mesial movement in response to the opening archwires. Therefore lacebacks and bendbacks may be dispensed with, so that anterior bracket tip can express itself.

The starting malocclusion often has canines which are tipped distally – an indication for very light opening archwire forces. Favorable anterior torque and vertical changes typically occur in these cases, early in treatment, and they are often not difficult to manage in anchorage terms.

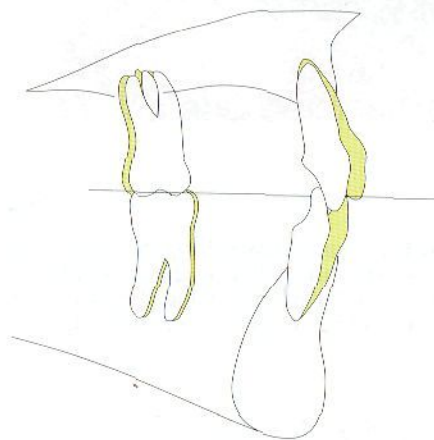


Fig. 5.5 Class II/2

MISTAKES IN TOOTH LEVELING AND ALIGNING IN THE EARLY YEARS

The tip built into the anterior brackets of the preadjusted appliance system caused considerable difficulties in the early years. The tip caused the crowns of the anterior teeth to incline forward during the initial phase of leveling and aligning (Fig. 5.6).

Early attempts were made to eliminate or minimize this effect by connecting anterior segments to posterior segments, usually with elastic forces. But this created a greater demand for anchorage control during this initial stage of treatment. Also, if the elastic forces were greater than the leveling force of the archwire, there was a tendency for anterior teeth to tip and rotate distally, increasing the curve of Spee and deepening the bite. This was particularly evident in first premolar extraction cases, and was referred to as the 'roller coaster' effect (Figs 5.7–5.9).

The 'roller coaster' effect is seldom seen in today's cases, owing to the reduced tip in the MBT™ bracket system, lighter archwire forces, and use of lacebacks for canine control instead of elastic chain.

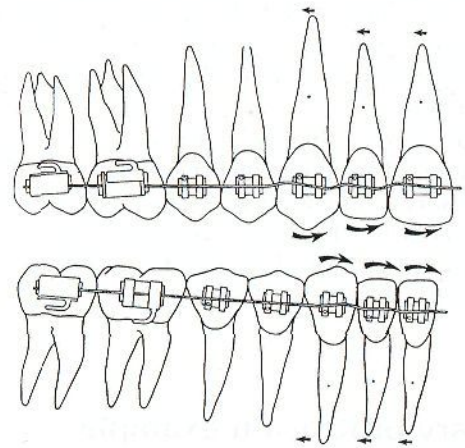


Fig. 5.6 The tip built into the anterior brackets of the preadjusted appliance system causes the crowns of the anterior teeth to incline forward during early leveling and aligning.

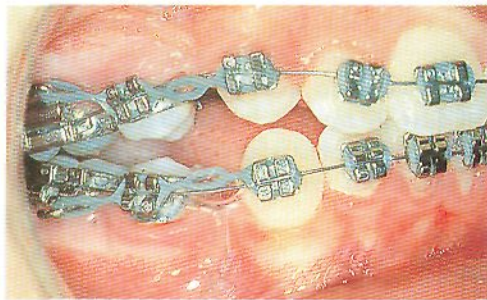


Fig. 5.7

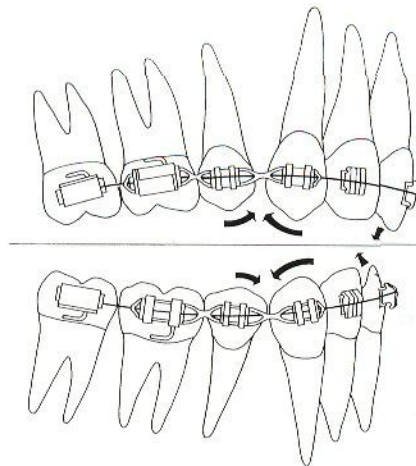


Fig. 5.8

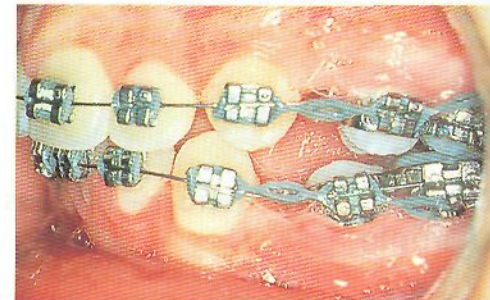


Fig. 5.9

Fig. 5.7 to 5.9 Use of elastic force for canine retraction, and excess force generally, produces a tendency for deepening of the anterior bite. Also, there is a tendency to lateral open bite, the overall outcome being referred to as the 'roller coaster' effect. In treatments in the 1970s and 1980s, the effects of elastic forces applied to canines early in extraction treatment with light archwires in place were found to be: (a) tipping and rotation into extraction sites; (b) bite opening in the premolar regions; (c) bite deepening anteriorly.

REDUCED ANCHORAGE NEEDS DURING TOOTH LEVELING AND ALIGNING

Where possible, the anchorage needs of a case should be reduced. This will lessen the need for anchorage control and support measures such as palatal and lingual bars or headgears, and this in turn will simplify the treatment and may make fewer demands on patient cooperation. The measures described below have been found to reduce demands on anchorage and thereby improve treatment efficiency.

Bracket design

Bracket tip is the major factor in anchorage demands early in treatment. Any reduction in built-in tip is beneficial in reducing the anchorage needs of a case. The MBT™ Versatile+ bracket system is based on the original research values for tip. A total of 10° less distal root tip in the upper anterior segment and 12° less distal root tip in the lower anterior segment is needed, compared with the original SWA (Fig. 5.10). This reduces the anchorage needs, lessens the tendency to bite deepening in the early stages, and puts less demand on patient cooperation.

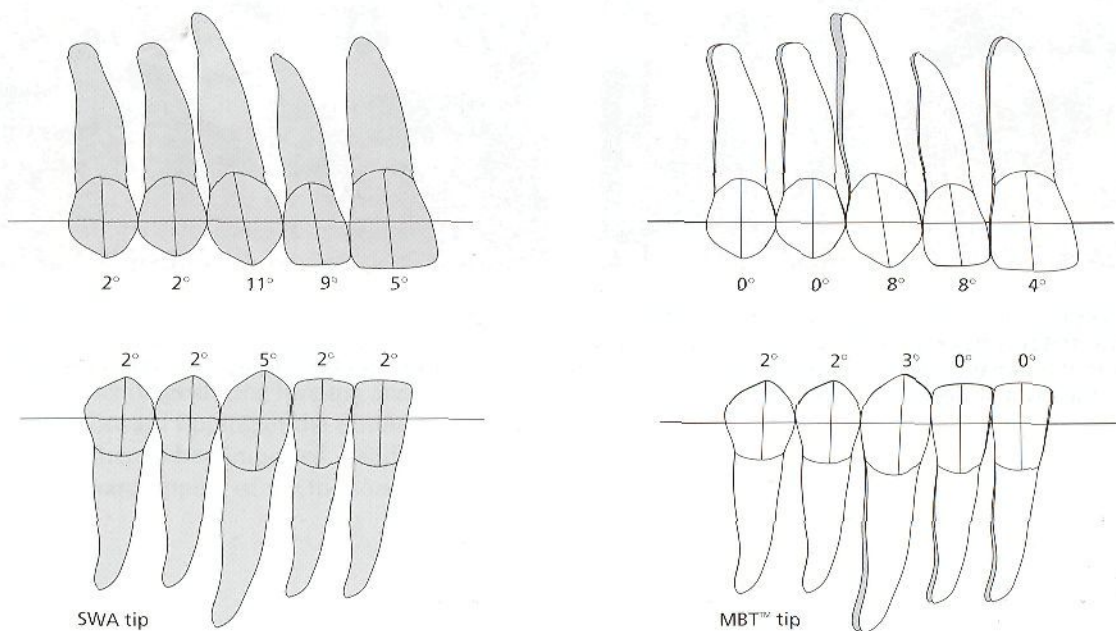


Fig. 5.10 The MBT™ bracket system has 10° less distal root tip in the upper anterior segment and 12° less distal root tip in the lower anterior segment compared with SWA. This is beneficial in reducing anchorage demands early in treatment.

Archwire forces

The use of very light archwire forces (p. 112) early in treatment will be more comfortable for the patient, and will put less demand on anchorage. When unsure about which of two wires to use, it is normally preferable to use the lighter one. There is also a need to avoid changing wires too frequently.

Avoidance of elastic chain

As previously discussed (p. 98), many problems in the past emanated from the use of elastic retraction mechanics, especially in first premolar extraction cases. These should be avoided.

ANTERO-POSTERIOR ANCHORAGE SUPPORT DURING TOOTH LEVELING AND ALIGNING

Lacebacks for A/P canine control

Lacebacks² are .010 or .009 ligature wires which extend from the most distally banded molar to the canine bracket (Figs 5.11 & 5.12). They restrict canine crowns from tipping forward during leveling and aligning. They are mainly used in premolar extraction cases, but they may also be required in some non-extraction cases where there is a local threat to anchorage. For example, if the root of a canine is mesially placed (Fig. 6.21, p. 140), this will effectively increase the tip in the canine bracket at the start of treatment, and hence increase the anchorage needs of that tooth.

Lacebacks are passive devices, and should not be overtightened to an extent that tissue blanching occurs. They are placed before the archwire. At monthly adjustment visits, the lacebacks are normally loose, and require 1–2 mm of tightening.

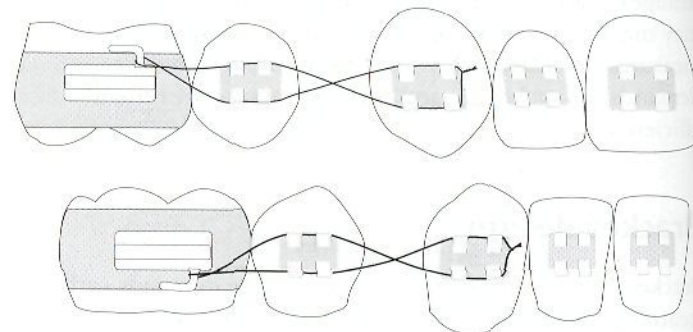


Fig. 5.11 .010 or .009 ligature wires are used for canine lacebacks, which are used mainly in premolar extraction cases.

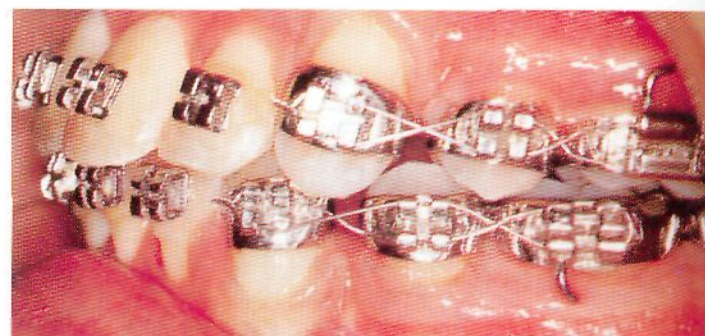


Fig. 5.12 Lacebacks have been an integral part of the authors' treatment philosophy for many years. This first premolar extraction case, treated in the 1980s with original SWA, shows upper and lower lacebacks in place. Lacebacks may be tied round the molar attachment or from the molar hook. If tied round the molar attachment, it is often necessary to use an explorer to prevent the laceback blocking the distal aspect of the molar tube.

Robinson³ investigated 57 premolar extraction cases, approximately half of which were treated with lacebacks and half without. His findings are summarized below (Fig. 5.13).

The initial purpose of lacebacks was to prevent canines from tipping forward, but it was observed that, where necessary, these ligature wires were an effective method of distalizing the canines without causing unwanted tipping.

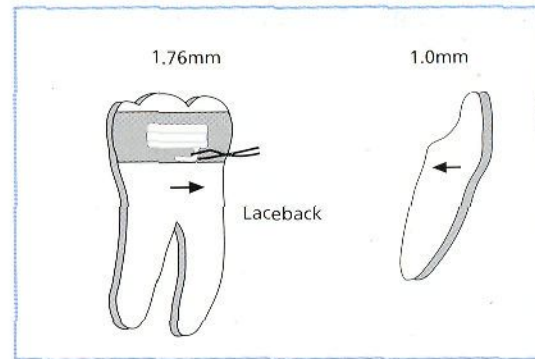
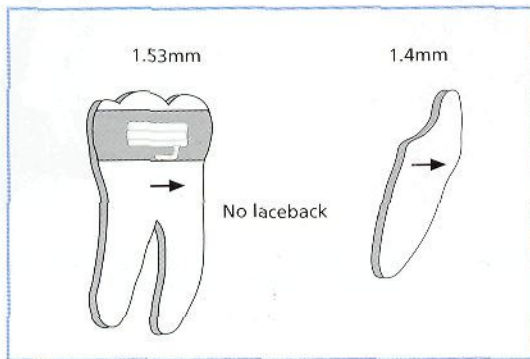


Fig. 5.13 The work of Robinson confirms that lower canine lacebacks have a beneficial effect in controlling proclination of lower incisors. Without lacebacks, on average the lower incisor moved forwards 1.4 mm. In contrast, with lacebacks in place, the lower incisors moved 1.0 mm distally.

Lacebacks are normally continued throughout the leveling and aligning archwire sequence, up to and including the rectangular HANT stage. Thereafter, in the rectangular steel wire stage, A/P control is continued with passive tiebacks (Fig. 9.17, p. 255).

During leveling and aligning, it is preferable to maintain the anterior six or eight teeth as a group, except in some midline problems, where canine retraction is called for (Fig. 5.15), and in some cases where it is necessary to maintain a Class I canine relationship (Case JN, p. 122). Accordingly, in most cases lacebacks are discontinued if a space occurs between the canine crown and the adjacent lateral incisor.

Lacebacks and bendbacks are the primary method of supporting anterior anchorage during leveling and aligning. Lacebacks minimize forward tipping of the canine crowns and can effectively retract them when indicated. Bendbacks are used to minimize forward tipping of the incisors, as discussed below.

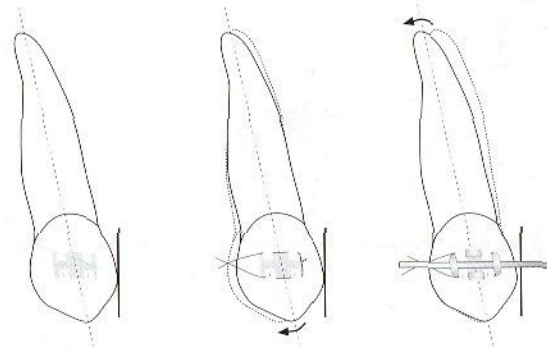


Fig. 5.14 The probable action of the lacebacks on the canine during tooth leveling and aligning involves initial slight tipping followed by a period of rebound.

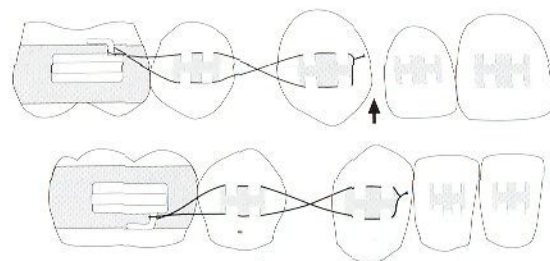


Fig. 5.15 In most treatments, it is preferable not to retract the canine away from the lateral incisor. However, in cases with small lateral incisors, midline discrepancies, or a need to maintain a Class I canine relationship, it may be appropriate to retract the canine away from the lateral incisor.

Bendbacks for A/P incisor control

These are used as an important method of anchorage support, often in combination with lacebacks. If the archwire is bent back immediately behind the tube on the most distally banded molar, this serves to minimize forward tipping of incisors (Fig. 5.16 A–C).

If the opening wire is .015 multistrand, it may be turned into a small circle distal to the molar tube (Fig. 5.17).

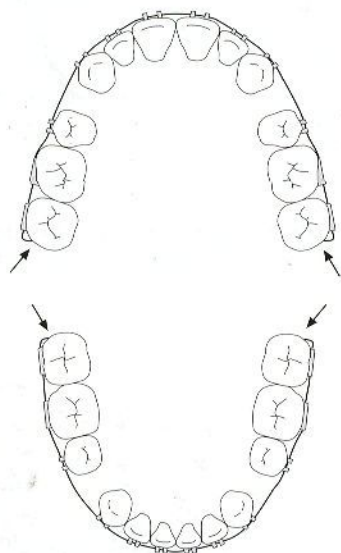


Fig. 5.16A Bendbacks are an important method of anchorage support and can minimize forward tipping of incisors.

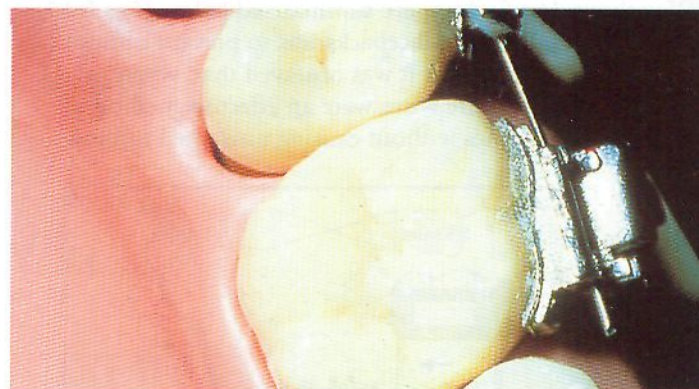


Fig. 5.16B Steel and HANT wires should have the terminal 3 mm flamed and quenched before placement.

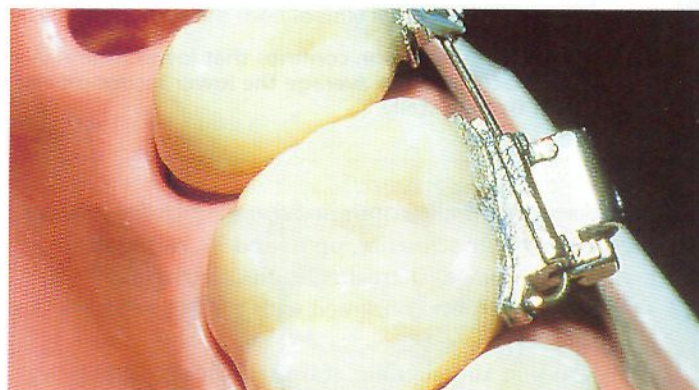


Fig. 5.16C The softened end of the archwire can easily be turned in to form a bendback. The softening facilitates removal of the archwire at the subsequent adjustment visit.

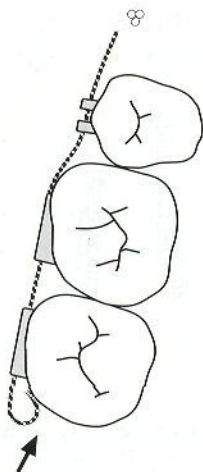


Fig. 5.17 Multistrand wires may be carefully turned into a small circle distal to the molar tube to create a bendback.

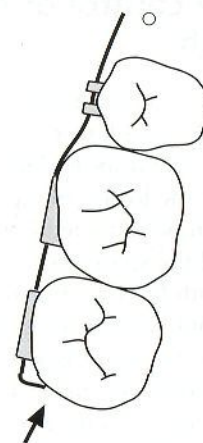


Fig. 5.18 Bendbacks are possible when using .016 HANT wires, providing the terminal 3 mm is flamed and quenched in cold water before placement of the archwire.

The ends of the .016 HANT wires and round steel wires need to be flamed and quenched in cold water before placement, to allow accurate bendbacks (Figs 5.18 & 5.19). The rectangular HANT wires may be thinned at their terminal 3 mm and then flamed and quenched, to avoid de-bonding bonded molar tubes when creating bendbacks (Fig. 5.20) and to facilitate removal of the archwire for adjustment. A green stone is used for the thinning.

Like lacebacks, bendbacks are normally continued throughout the leveling and aligning archwire sequence, up to and including the rectangular HANT stage, for any case which requires A/P control of incisors. Later, in the rectangular steel wire stage, the A/P control is continued with passive tiebacks (Fig. 9.17, p. 255, and Fig. 7.59, p. 186).

In cases where it is necessary to increase arch length during leveling and aligning (p. 40), and where A/P incisor control is not required, bendbacks should be placed 1 or 2 mm distal to molar tubes (Fig. 7.16C, p. 171).

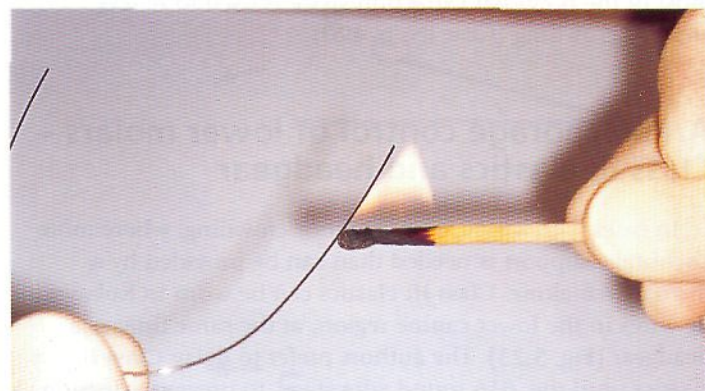


Fig. 5.19 It is helpful to flame the end of all archwires, except steel rectangular and multistrand wires, and then quench them in cold water before placement. This allows accurate bendbacks.



Fig. 5.20 Rectangular HANT wires may be thinned at their terminal 3 mm to allow creation of bendbacks after flaming and quenching.

A/P anchorage control of lower molars – the lingual arch

Soldered lingual arches may be used in the late mixed dentition in cases with mild lower arch crowding. The lower first molars will normally drift mesially into the leeway space from the shedding of the lower primary second molars (Figs 5.21 & 5.22). This can be restricted by the timely placement of a lingual arch, and the space used to assist lower anterior alignment during tooth leveling and aligning.

Lingual arches should also be considered for maximum anchorage premolar extraction cases. This will include many bimaxillary proclination cases and also cases with severe lower anterior crowding. In both these types of problem, it is necessary to consider using a lingual arch throughout the early stages of leveling and aligning. This will restrict the mesial movement of lower molars, and in the bimaxillary proclination cases, it will ensure that most of the premolar extraction space is available at the end of leveling and aligning, to provide for retraction of the anterior segment. In the severely crowded cases, the lingual arch will ensure that most of the premolar extraction space is used to relieve anterior crowding (Case JN, p. 120).

A/P anchorage control of lower molars – Class III elastics and headgear

In cases with severe lower anterior crowding, where more anchorage support is needed than can be provided by a lingual arch alone, Class III elastics can be worn to Kobayashi tie wires in the lower canine region, at the same time as a headgear (Fig. 5.23). The authors prefer to delay Class III elastics until the .016 round wire stage, to prevent extrusion of the incisors. Fortunately, few cases require this amount of lower arch anchorage support.

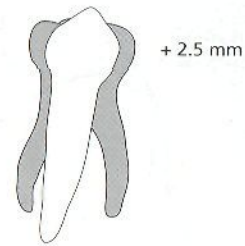


Fig. 5.21 Lower lingual arches may be used to prevent first molars drifting mesially into the available leeway space after shedding of the lower primary second molars. This averages 2.5 mm.

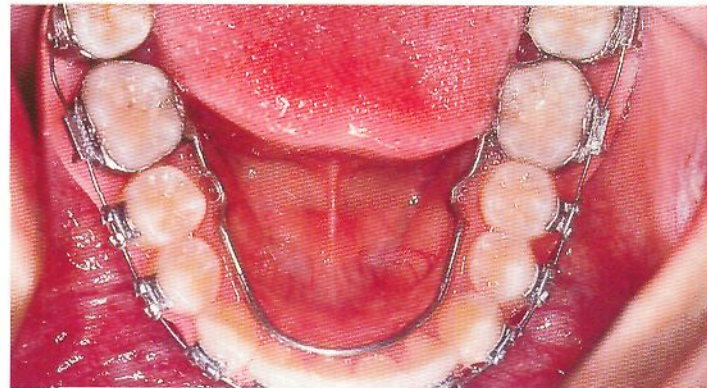


Fig. 5.22 Soldered lingual arches are helpful in maximum anchorage premolar extraction cases during tooth leveling and aligning. They normally need to be removed prior to space closure. They are also useful in protecting leeway space, as shown in this non-extraction case.

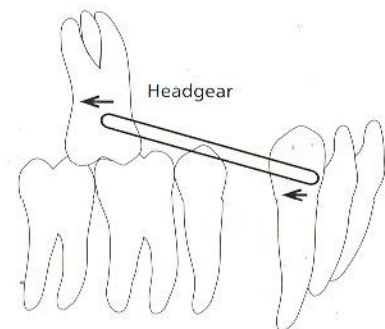


Fig. 5.23 Class III elastics can be worn in combination with a headgear for maximum anchorage support in the lower anterior segment.

A/P anchorage support and control for upper molars – the use of headgear

In certain cases, it may be necessary for the upper posterior segments to be limited in their mesial movement, maintained in their positions, or even distalized, to allow the anterior segments to be properly positioned in the face. Posterior anchorage control requirements are normally greater in the upper arch than in the lower arch owing to five main factors:

1. The upper molars move mesially more easily than the lower molars.
2. The upper anterior segment has larger teeth than the lower anterior segment.
3. The upper anterior brackets have more tip built into them than the lower anterior brackets.
4. The upper incisors require more torque control and bodily movement than the lower incisors, which only require distal tipping or uprighting.
5. In many practices in America and Europe, a typical caseload has more Class II type of malocclusions than Class III type.

Because of these factors, extra-oral force is normally the most effective method of posterior anchorage control in the upper arch, provided sufficient patient cooperation is available. The three primary types of facebow headgear and their force directions are shown (Fig. 5.24).

The authors favor a combination headgear (occipital pull and cervical pull) in most cases. The force levels used for the combination headgear are 150–250 gm for the occipital pull and 100–150 gm for the cervical pull. These force values allow for slightly stronger pull on the occipital component of the headgear, keeping forces directed slightly above the occlusal plane and minimizing the tendency for vertical extrusion of the upper posterior teeth, while simultaneously allowing effective distalization of the molar.

The length of the outer bow of the headgear is important to avoid unwanted molar tipping. It should end adjacent to the upper first molar (Fig. 5.25). An extended outer bow or an outer bow bent downward provides a greater tendency for distal tipping of the crown of the first molar. A shorter outer bow, or tipping up of the outer bow, causes a greater tendency for the roots to be distalized ahead of the crowns, as shown in the illustration. In high-angle cases where little distalization of the molar is required, an occipital headgear alone can be used. In very low-angle cases, where musculature is strong enough to minimize vertical extrusion of the posterior teeth, a cervical headgear alone can be considered.

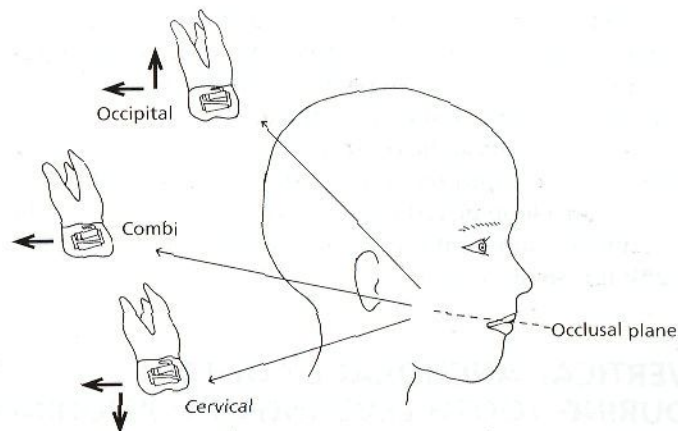


Fig. 5.24

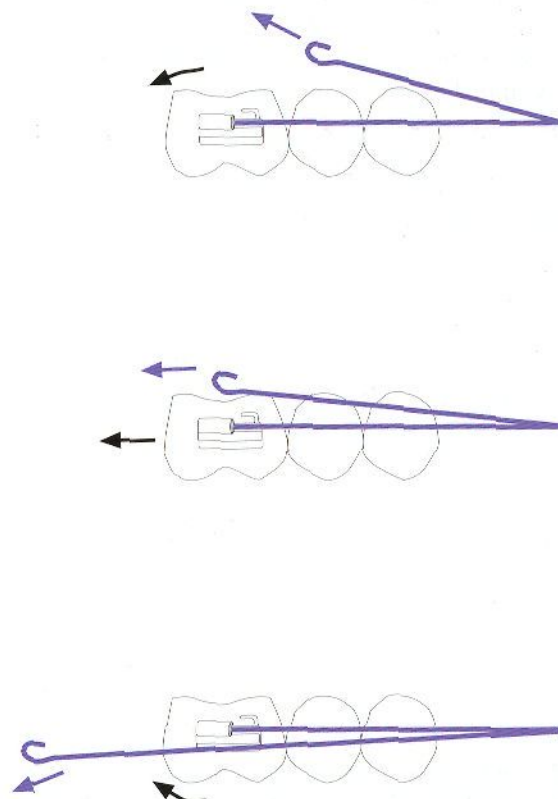


Fig. 5.25 This diagram shows the theoretical effect of variations in the length of the outer arm of the headgear bow.

A/P anchorage support and control for upper molars – the palatal bar

A second method of anchorage support in the upper posterior segment is the palatal bar. This is normally placed when the upper molars have been properly rotated and are situated in a Class I relationship to the lower molars.

The palatal bar can be constructed of heavy .045 or .051 inch (1.1 or 1.3 mm) round wire extending from molar to molar with a loop placed in the middle of the palate and the wire about 2 mm from the roof of the palate (Fig. 5.26 and 5.29). It is soldered to the molar bands.

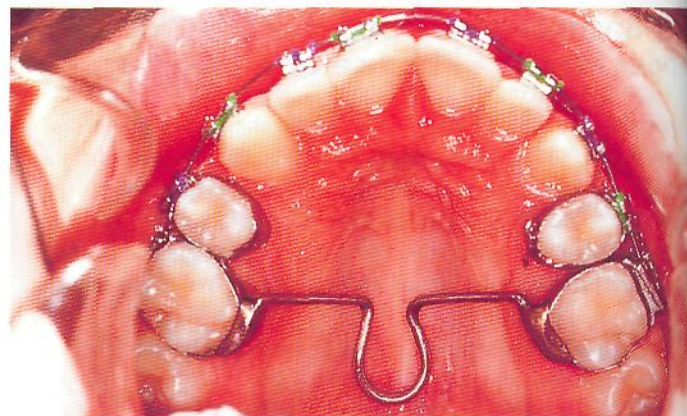


Fig. 5.26 Soldered palatal bars are helpful in restricting mesial movement of upper molars during tooth leveling and aligning.

VERTICAL ANCHORAGE CONTROL DURING TOOTH LEVELING AND ALIGNING

Vertical control of the incisors

As previously discussed, anterior control is needed to restrict the tendency to temporary increases in overbite (Fig. 5.27), especially in deep-bite cases. The effect of bracket tip is more extreme in the upper arch, and care is needed if the canines are distally tipped in the starting malocclusion. In such cases, as the archwire passes through the canine bracket slot it will lay incisally to the incisor bracket slots. If the wire is fully engaged into the incisors, it will tend to cause extrusion of these teeth, which is undesirable in most cases.

This effect can be avoided either by not bracketing the incisors at the start of treatment, or by not tying the archwire into the incisor bracket slots, but allowing it to lay incisally to the brackets until the canine roots have been uprighted and moved distally, under the control of the lacebacks. The incisors can then be engaged without causing unwanted extrusion.

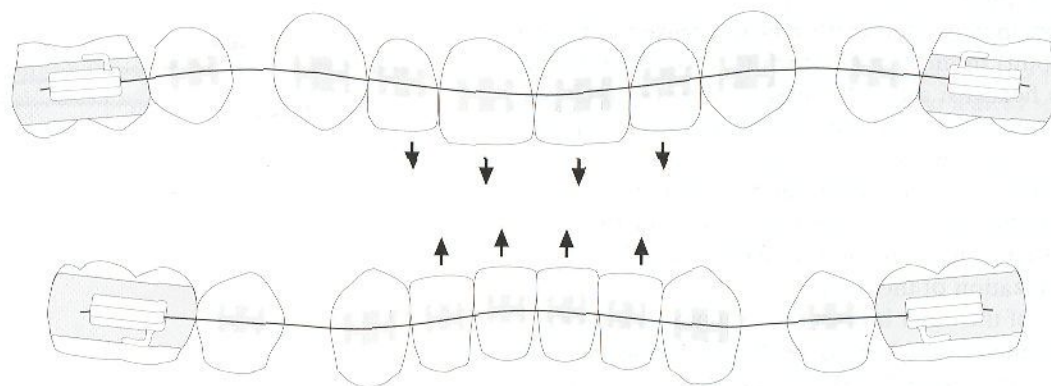


Fig. 5.27 The tip which is built into the anterior brackets of the preadjusted appliance system gives a tendency to temporary increases in overbite early in treatment. If the canines are distally tipped in the starting malocclusion, then the bite-deepening effect is greater.

Vertical control of canines

It is important to avoid early archwire engagement of high labial canines (Case JN, p. 121), so that unwanted vertical movement of lateral incisors and premolars does not occur (Fig. 5.28).

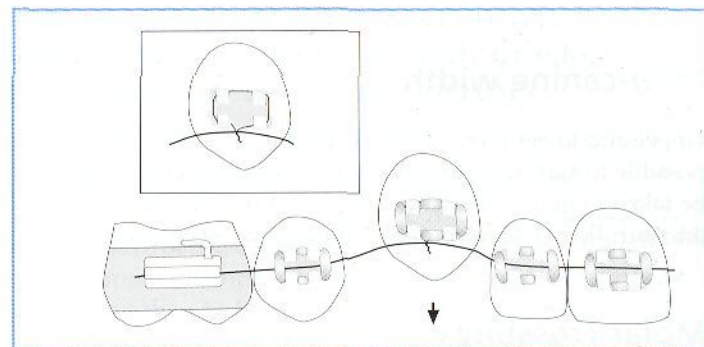
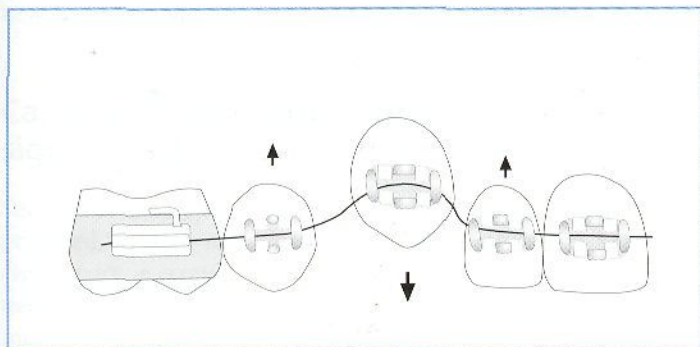


Fig. 5.28 High labial canines may be loosely tied to the .015 multistrand or .016 HANT wire in the early stages of treatment. If the starting archwire is fully engaged in the canine bracket slot, it can produce unwanted tooth movements in the adjacent lateral incisor and premolar regions.

Vertical control of molars in high-angle cases

When treating high-angle cases, the following methods of vertical molar control should be considered:

- Upper second molars are generally not initially banded or bracketed, to minimize extrusion of these teeth. If they require banding, an archwire step can be placed behind the first molar to avoid extrusion.
- If the upper first molars require expansion, an attempt is made to achieve bodily movement rather than tipping, to avoid extrusion of the palatal cusps. This is best accomplished with a fixed expander, sometimes combined with a high-pull headgear.
- If palatal bars are used, they are designed to lie away from the palate by approximately 2 mm so that the tongue can exert a vertical intrusive effect (Fig. 5.29).
- When headgears are used in high-angle cases, either a combination pull or a high-pull headgear is used. The cervical pull headgear is avoided.
- In some cases, an upper or lower posterior biteplate in the molar region is helpful to minimize extrusion of molars.

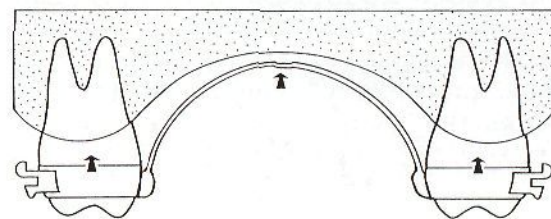


Fig. 5.29 If the upper palatal bar is placed 2 mm away from the palate, tongue forces can assist in vertical control of the molars.

ANCHORAGE CONTROL IN THE LATERAL (CORONAL) PLANE

In most cases, no special care is needed to maintain lateral anchorage control. However, attention needs to be paid to inter-canine width in all treatments, and molar crossbites are important in certain treatments.

Inter-canine width

Upper and lower inter-canine width should be kept as close as possible to starting dimensions for stability, and care should be taken to ensure that crowding is not relieved by uncontrolled expansion of the upper and lower arches.

Molar crossbites

Care is needed to avoid arbitrary correction of molar crossbites by tipping movements. This allows extrusion of palatal cusps and unwanted opening of the mandibular plane angle in treatment of high-angle, and even routine, Class II/1 problems. Whenever possible, molar crossbites should be corrected by bodily movement.

An assessment of maxillary bone can be made, and if it is too narrow, early rapid expansion should be considered as a separate procedure prior to leveling and aligning. If adequate maxillary bone exists, a fixed quadhelix expander can be effectively used. Minimal molar crossbites can usually be corrected in the final stage of leveling and aligning using rectangular wires which are slightly expanded from the normal form and which carry buccal root torque.

www.allislam.net
Problem

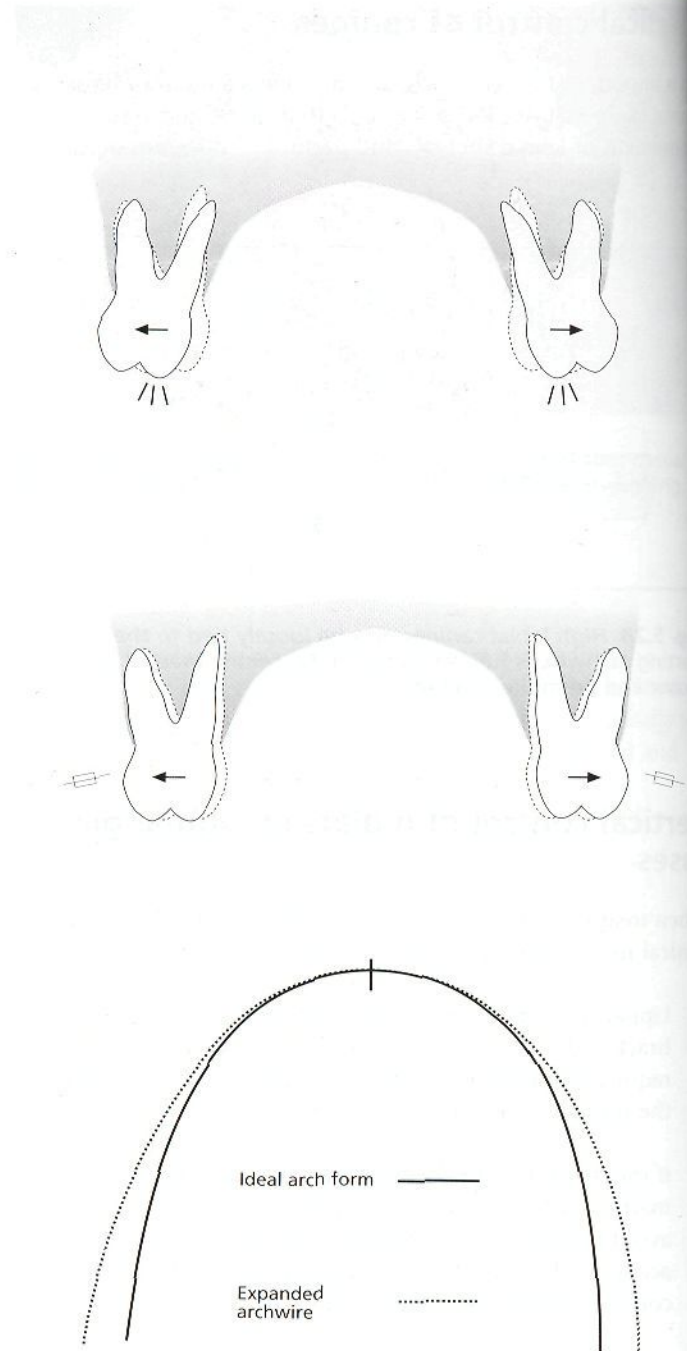


Fig. 5.30 Upper molar expansion should be carried out by bodily movement rather than tipping. Minimal molar crossbites can be corrected using rectangular steel wires which are slightly expanded from the normal form and which carry buccal root torque.

EXCEPTIONS TO FULL BRACKET PLACEMENT

Placement of brackets or bands on all possible teeth is recommended at the start of most treatments. This allows for the earliest possible stabilization of arch form, and also helps control the cuspids. However, there are exceptions to full bracket placement.

Cases with unerupted teeth, or teeth significantly out of the arch form

Such teeth can be left unbracketed until adequate space is provided for their movement and positioning (Fig. 5.31). Once space is created, these teeth can be bracketed and lightly tied with elastic thread to the main archwire. Sufficient space must be opened for movement of instanding teeth so that they do not fulcrum at the contact area, causing improper root positioning. The creation of adequate space allows bodily movement of these teeth into the arch form and more correct

root positioning, reducing the treatment needs in the finishing phase.

High-angle deep-bite cases in which the upper incisors interfere with bracket placement on the lower incisors

These cases are unusual, but when they occur, the upper incisors can be bracketed and the lower incisors left unbracketed at the start of treatment. After leveling and aligning have occurred in the upper arch for 2 to 3 months and the upper incisors have been slightly advanced, the lower incisors can then be bracketed. This prevents unnecessary extrusion of posterior teeth during the leveling procedure. In low-angle deep-bite cases, a biteplate can be placed at the initial bonding visit, provided the occlusion allows this.

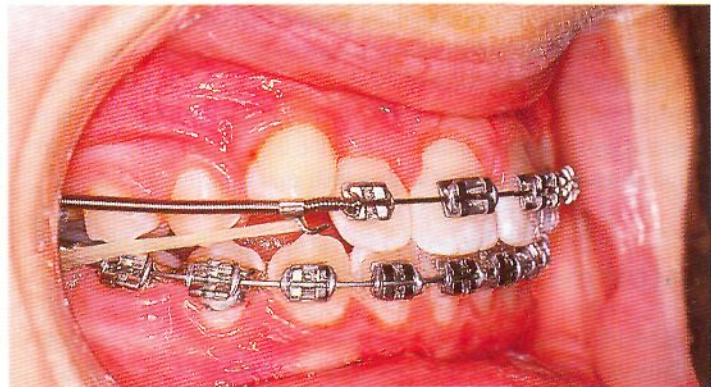
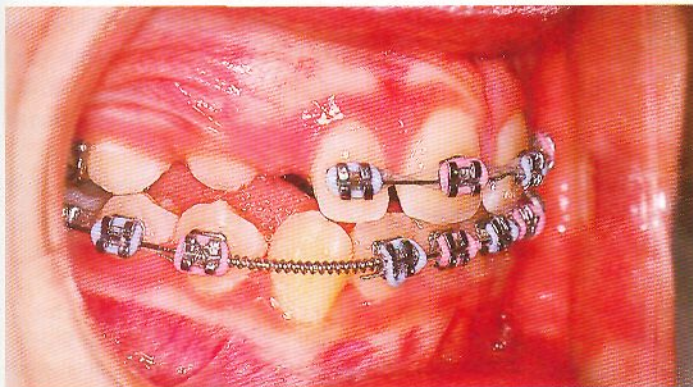


Fig. 5.31 Teeth which are significantly out of the arch form should be left unbracketed until adequate space is provided for their movement and positioning. The above examples show space being created for lower canines (Case LB, p. 116) and upper canines (Case TC, p. 192).

RE-LEVELING PROCEDURES

It is necessary to repeat leveling and aligning procedures in many cases when using preadjusted appliances. Re-leveling is needed when newly erupted teeth are included for the first time, or when bracket and bands are re-cemented, either because of breakage or incorrect original positioning. During treatment, re-leveling should be carried out as few times as possible for treatment efficiency, but even experienced clinicians can fail to place all brackets accurately at their first attempt. During early leveling and aligning, these errors can be identified, and it is better to reposition brackets rather than making archwire bends throughout subsequent treatment.

Incorrectly positioned brackets can be repositioned when newly erupted or poorly positioned teeth are bracketed for the first time, because it is necessary to return to lighter archwires to pick up these teeth. Also, if second molars have not been banded until after a stage of treatment such as space closure or overjet reduction, brackets can be repositioned at the second molar banding visit. In this way, re-leveling can occur without loss of treatment time.

WIRE SEQUENCING DURING TOOTH LEVELING AND ALIGNING

Historical background

Round and rectangular steel archwires were used with the standard edgewise appliance and during the early years with the preadjusted appliance. Round steel wires were used in sizes .014, .016, .018, and .020.

Rectangular steel wires were available in a number of sizes, with .018/.025, .019/.025, and .0215/.025 being the most popular wires used with the .022 bracket slot. The authors prefer the .022 slot over the .018 slot, primarily because of the rigidity needed in the archwire during space closure with sliding mechanics.

The .014, .016, .018, and then .020 round wire sequence was used by the authors, followed by the .019/.025 rectangular steel wire (Fig. 5.32). This wire allows for efficient sliding mechanics, unlike the larger .0215/.025 wire, which creates excess friction during space closure. Also, the .019/.025 rectangular wire shows less deflection than the more flexible .018/.025 wire.

One of the early attempts at producing archwires with greater flexibility involved twisting together strands of very small stainless steel wires (Fig. 5.33). These were referred to as multistrand wires. These wires, in sizes .015 and .0175, were used as initial wires, prior to the use of the .014 round steel wire, in cases with significant tooth malalignment.

Recommended sequencing

The introduction of nickel-titanium wires provided a possible substitute for multistrand and steel round wires during the leveling and aligning stages of treatment. One nickel titanium wire could be used in place of approximately two sizes of stainless steel wires. However, given their higher cost, their significance was considered questionable by many clinicians. They were also mistakenly used during procedures that required the rigidity of a rectangular stainless steel wire, such as complete arch leveling, overbite control, space closure, and overjet reduction with inter-maxillary elastics.

The development of copper nickel-titanium wires, referred to as 'heat-activated' wires, provided wires with significantly greater flexibility. As a result, these wires could be used as a substitute for three of the traditional stainless steel wires in certain situations, which was a significant improvement.



Fig. 5.32 Round and rectangular steel wires were used during the early years with the preadjusted appliance.

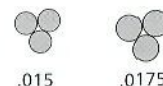


Fig. 5.33 Multistrand wires were produced to introduce greater flexibility. They are currently used as initial wires in cases with significant tooth malalignment.

Instead of replacing wires on a per visit basis during leveling and aligning, a coolant could be applied to the heat-activated nickel-titanium (HANT) wire in the areas where full bracket engagement had not been achieved, and the wire could be retied for complete engagement. The normal warmth of the oral cavity produced significant activation of the wire and very efficient tooth movement. Surprisingly, patients did not seem to complain of added discomfort, probably because of the light forces that were introduced.

The archwire sequence shown (Fig. 5.34) has been employed by the authors. It has significantly reduced chairside time and increased the efficiency of tooth movement, owing to the minimizing of permanent archwire deflection.

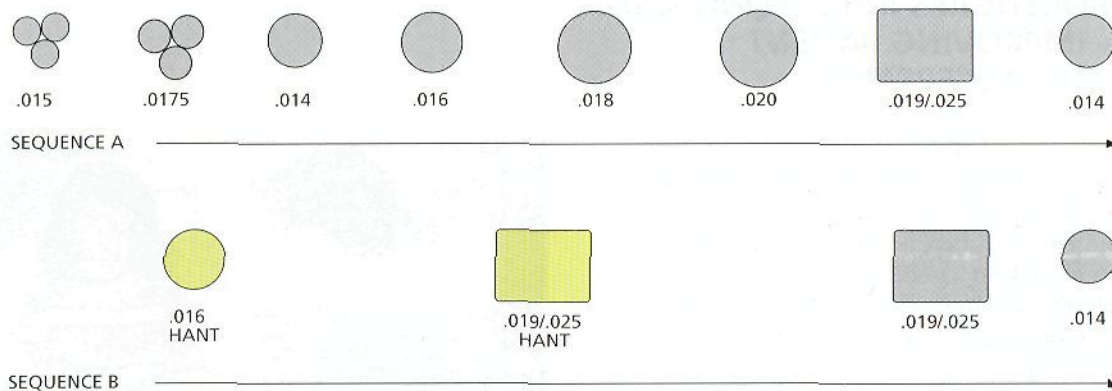


Fig. 5.34 In some cases, the authors can follow sequence B to complete a treatment with very efficient mechanics and few archwire changes. However, in many treatments it is necessary to use some wires from the more traditional sequence A, and these are discussed below.

HEAT-ACTIVATED NICKEL-TITANIUM (HANT) OR STAINLESS STEEL?

Because of their flexibility, there are clinical situations where heat-activated wires are not recommended, or where some stainless steel wires should also be used. These clinical situations are described below:

- Initial wires in cases with severe malalignment of teeth. It is a service to the patient to place a multistrand wire as the first wire in such cases. The permanent deflection that occurs with these wires reduces the overall force levels and produces less discomfort during the initial 'experience with braces'. Also, some wire bending in addition to the normal arch form may be required, and is easily accomplished with multistrand wires.
- When using lacebacks for cuspid retraction in crowded extraction cases. The use of lacebacks minimizes the tipping of the cuspids into the extraction sites. However, with prolonged use of flexible heat-activated wires, some tipping can occur. To reduce this possibility, a .018 or .020 stainless steel wire should be used as early as possible when using lacebacks.
- When using open coil spring in the anterior or posterior segments to create space for blocked-out teeth. Because of their flexibility, the use of open coil springs on heat-activated wires can cause significant distortions in arch form. Thus, open coil springs should not be used until .018 or .020 round steel wires are in place.

- For complete arch leveling and overbite control. While heat-activated wires are excellent for individual tooth alignment, they are not effective for complete arch leveling and subsequent bite opening. Hence, the transition from even the rectangular heat-activated wires to the rectangular stainless steel wire is sometimes impossible. A .020 round steel wire is often required before the rectangular stainless steel wire.
- For torque control. Rectangular heat-activated wires commence the process of torque control, but this difficult tooth movement is best completed by using a rectangular stainless steel wire.
- For the treatment stages of space closure and overjet reduction. The major tooth movements that occur during these stages of treatment require the rigidity of a rectangular stainless steel wire, as opposed to the flexibility of a heat-activated wire.

In summary, the introduction of heat-activated wires has provided a beneficial substitute for a number of traditional stainless steel wires, and can dramatically improve the efficiency of orthodontic treatment. This substitution is, however, beneficial for initial tooth alignment procedures only. The flexibility of heat-activated wires can actually be detrimental in a number of other clinical situations, as described above. It is important that the orthodontist separates the situations that require archwire flexibility from those in which archwire rigidity is needed.

CLINICAL PROCEDURES IN LEVELING AND ALIGNING – IMPROVING PATIENT COMFORT AND ACCEPTANCE

At the start of treatment, every effort should be made to ensure that discomfort and inconvenience for patients are minimized. This will normally be their first experience of orthodontic treatment, and there are opportunities for the orthodontic team to make it a good experience.

For many cases, the opening wires will be .016 HANT, but if there are major tooth malalignments, a multistrand .015 wire is preferable. Bends can be introduced into .015 multistrand wires, and these reduce the force applied to the teeth at the outset (Case JN, p. 120 and Case DO, p. 208). The opening wires should not be tied in tightly. Plastic sleeving should be used to make lengthy stretches of archwire more comfortable.

The patient should be given proper instruction on the use of wax and mild analgesics (Fig. 5.35). A good supply of wax should be provided, and it should be made clear that most discomfort will disappear after the first few days.

Archwire ends should be carefully turned in, and particular care is needed with multistrand wires. Steel and HANT wire-ends should be flamed and quenched, to allow accurate turning in, and also ease of removal at the first adjustment appointment. Molar hooks should be turned in (Fig. 5.36A).

Much can be made of selecting colored modules at the first visit, for those patients who like the idea of colors. There is a colored module culture among some groups of youngsters (Fig. 5.36B)! Self-ligating brackets may be an inevitable development in the future, but this will be a concern for many younger patients, who look forward to choosing colors at each visit.



Fig. 5.35 The patient should be properly instructed on the use of wax and mild analgesics.



Fig. 5.36A Molar hooks should be turned in.

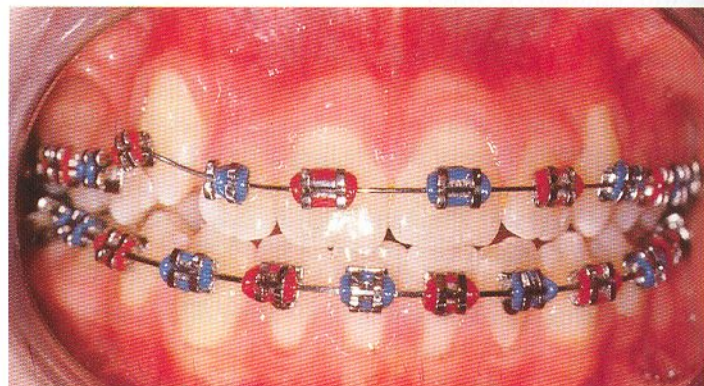


Fig. 5.36B Many younger patients look forward to choosing coloured modules at each visit.



Fig. 5.37 A follow-up phone call should be made 5–7 days after placement of the initial appliance.

It is correct to have a senior assistant make a follow-up phone call a few days after placement of the initial appliances (Fig. 5.37). This will show that the practice is concerned to know that all is going well, and it is a chance to offer advice and encouragement. During this call, the patient or parent will often raise minor queries, which are important to them, although they 'didn't want to bother the doctor'.

As leveling and alignment progresses, there will be a switch into rectangular HANT wires. This can typically follow directly from the .016 round HANT in many cases. The rectangular HANT wires are most useful and patient-friendly, and the switch is therefore seldom accompanied by discomfort. Any brackets which are wrongly positioned should be repositioned at the rectangular HANT wire stage, or earlier.

Although there have been many technical advances in orthodontics, there is a continuing need to ensure good patient cooperation, in order to reach treatment goals. Care and consideration from the outset will provide a sound basis for the treatment relationship. This should lead on to better cooperation in many cases.

REFERENCES

- 1 McLaughlin R P, Bennett J C 1999 An analysis of orthodontic tooth movement – the VTO. *Revista Espana Ortodontica* 29(2):10–29
- 2 McLaughlin R P, Bennett J C 1989 The transition from standard edgewise to preadjusted appliance systems. *Journal of Clinical Orthodontics* 23: 142–153
- 3 Robinson S N 1989 An evaluation of the changes in lower incisor position during the initial stages of clinical treatment using a preadjusted edgewise appliance. University of London MSc thesis

CASE LB

A female patient, 11.5 years old, with near average MM angle of 29° , slight Class III skeletal bases (ANB 1°) and a deep bite. Lower incisors were retroclined and crowded.

All permanent teeth were developing, and there was a possible supernumerary tooth in the upper right third molar region. The patient was informed that surgical uncovering of the upper canine crowns might be needed during treatment.

It was planned to treat the case without extractions. Mid-sized brackets were placed with a .014 sectional steel upper wire, and a .016 lower round HANT wire to commence tooth movements. The patient was asked to wear a sleeping combination headgear. An upper acrylic removable bite plate was supplied for full-time wear.



Fig. 5.38



Fig. 5.41

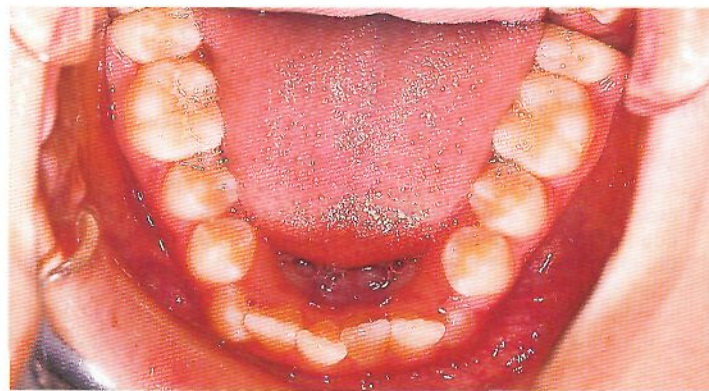


Fig. 5.44

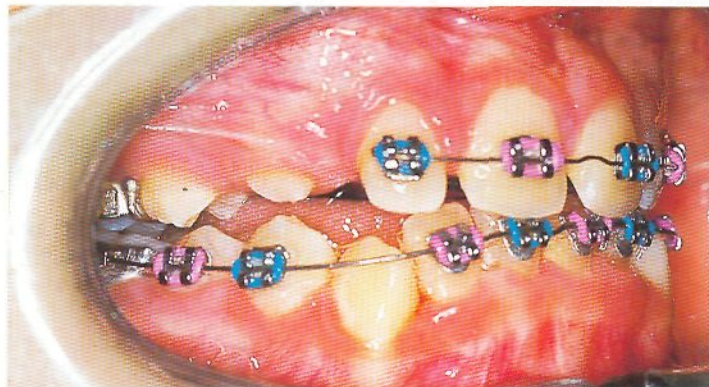


Fig. 5.47



Fig. 5.39

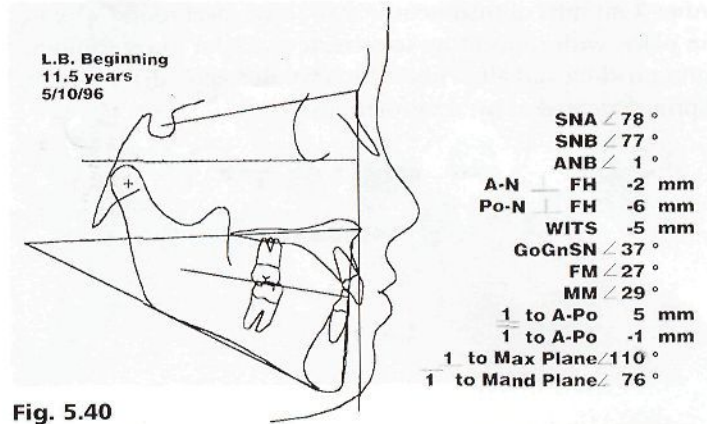


Fig. 5.40

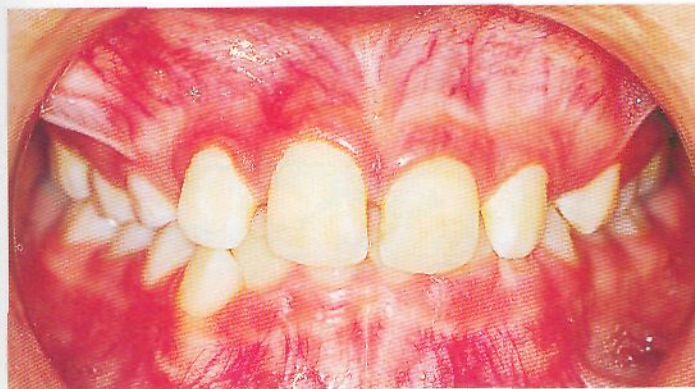


Fig. 5.42

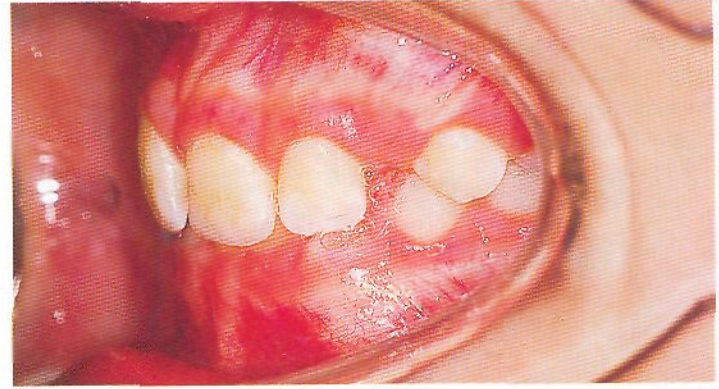


Fig. 5.43

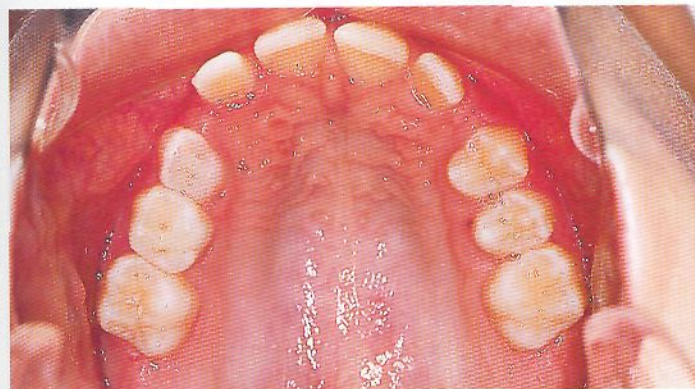


Fig. 5.45



Fig. 5.46

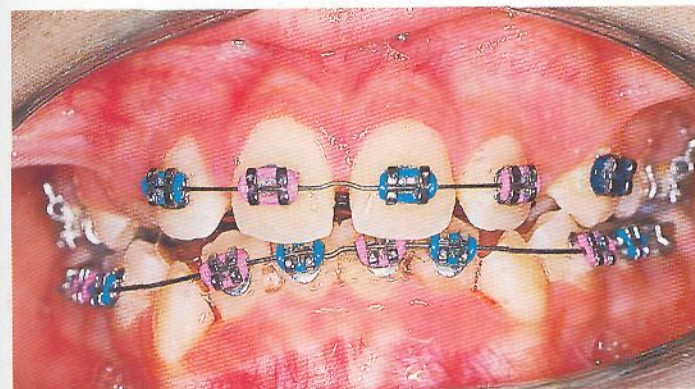


Fig. 5.48

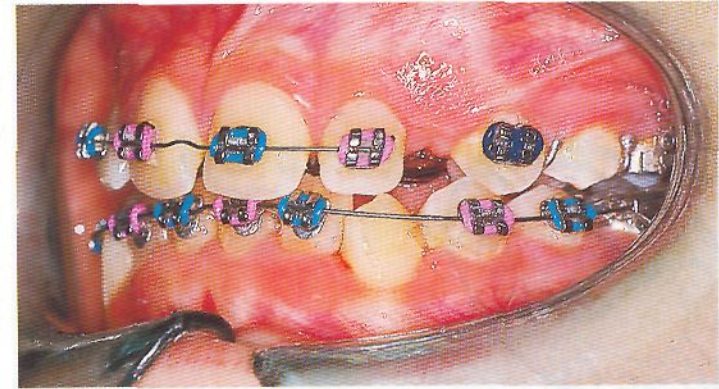


Fig. 5.49

After 3 months of treatment, a .016 lower steel round wire is in place, with coil springs to recreate space for lower canines, and procline and align lower incisors. Brackets adjacent to the springs are tied to prevent rotations.

A sequence of slides of the right side of the treatment after 10 months, 18 months, and 21 months, showing creation of upper canine space and then bonding of a button after uncovering. During treatment, lower right central and both upper first premolar brackets were repositioned.

Normal .019/.025 rectangular steel wires in place after 22 months of treatment. The patient was asked to wear light Class II elastics at this stage. Some lower arch enamel reduction was carried out.

The recommended settling protocol was followed with a sectional upper .014 wire and a .016 HANT lower wire.

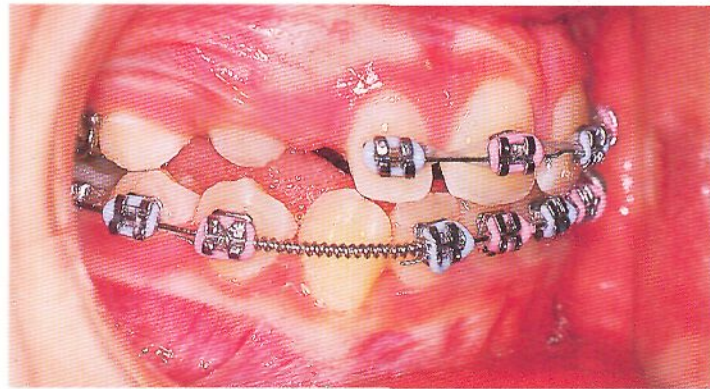


Fig. 5.50

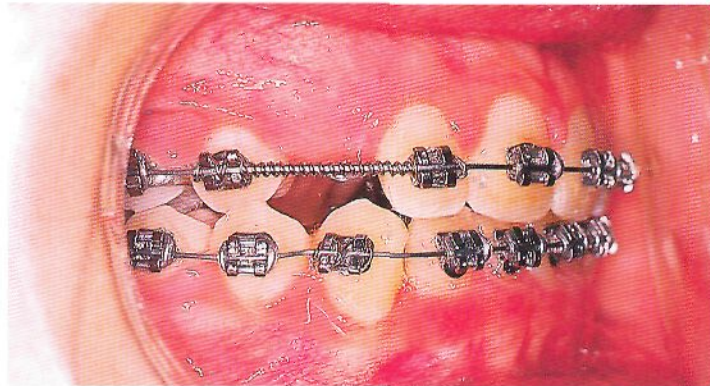


Fig. 5.53

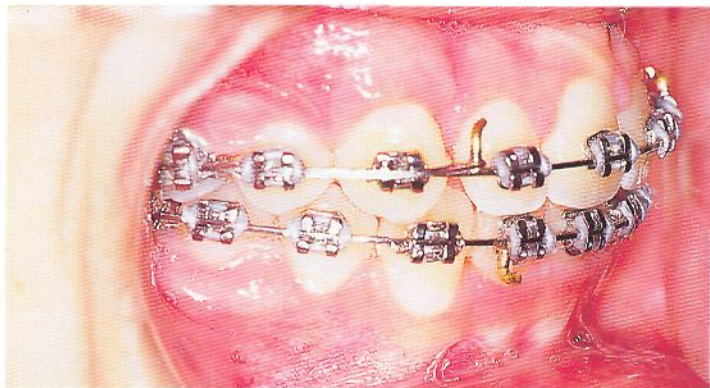


Fig. 5.56



Fig. 5.59

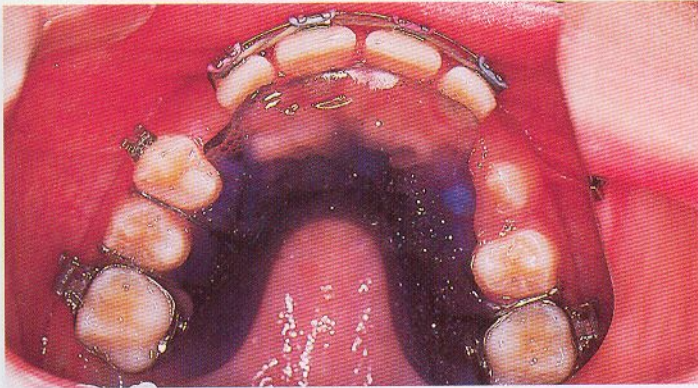


Fig. 5.51

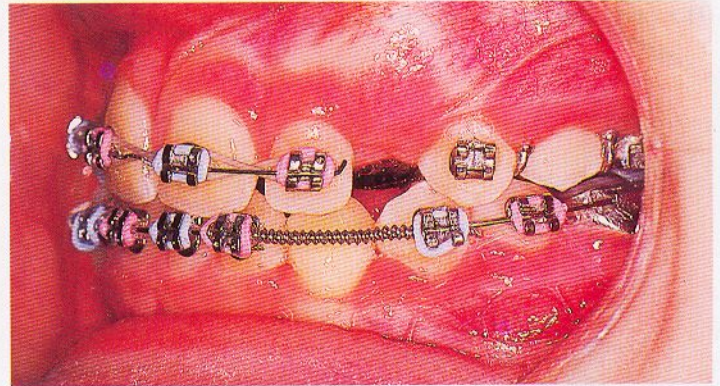


Fig. 5.52

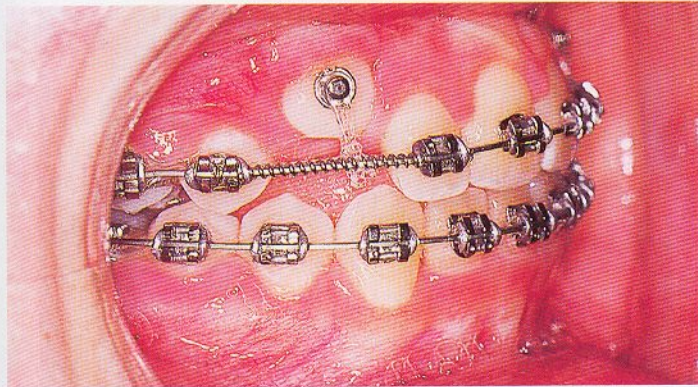


Fig. 5.54

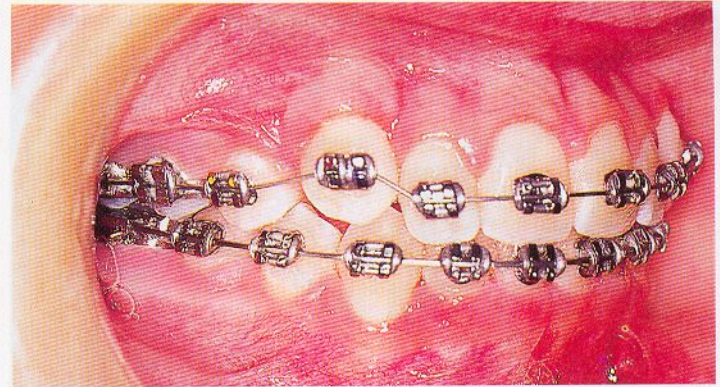


Fig. 5.55

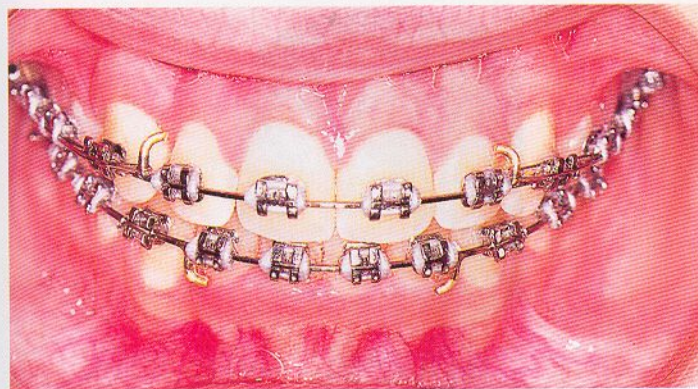


Fig. 5.57

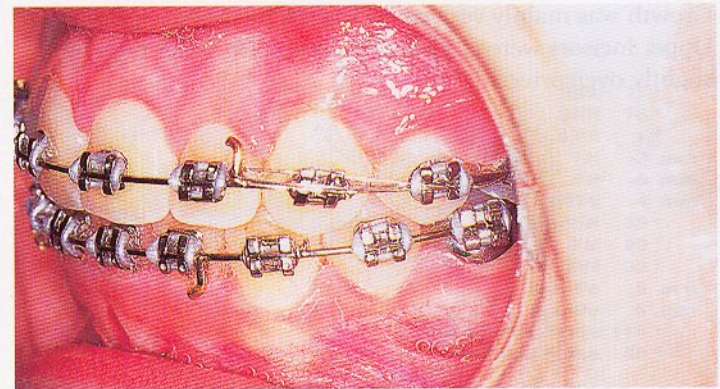


Fig. 5.58

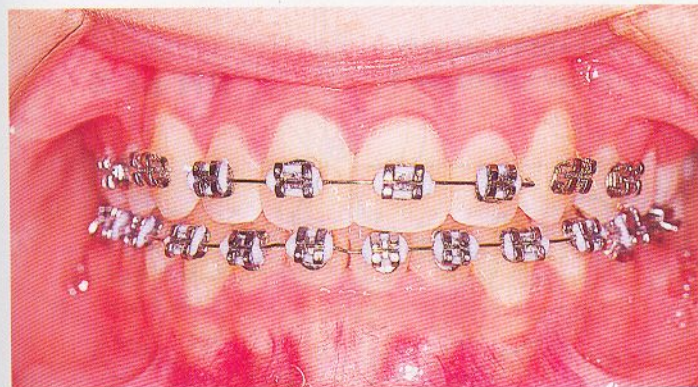


Fig. 5.60



Fig. 5.61

The case after appliance removal.

The patient was referred for a surgical opinion concerning the third molars and the supernumerary tooth.

Growth was mainly vertical during the treatment period. Upper incisors were at ideal positions, with lower incisors slightly overcorrected.



Fig. 5.62

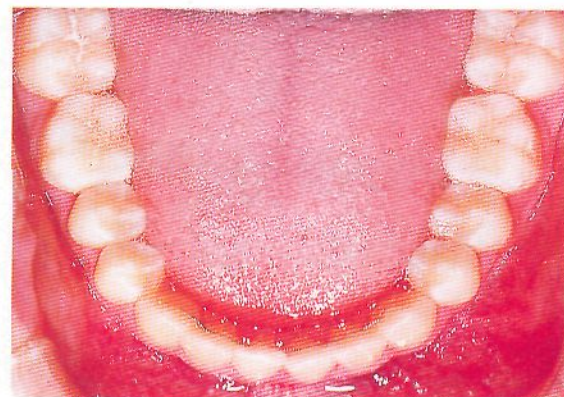


Fig. 5.65



Fig. 5.68

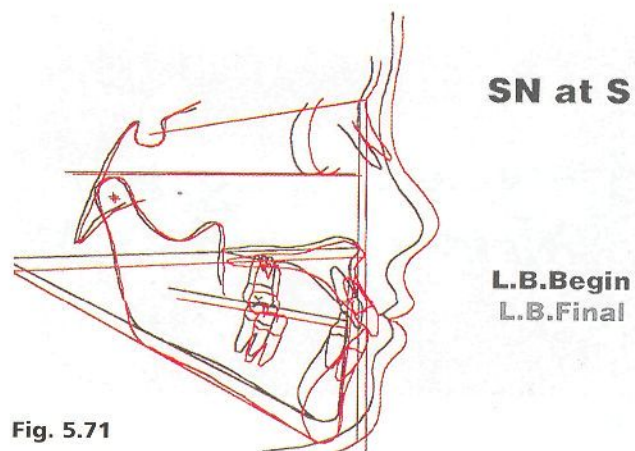


Fig. 5.71



Fig. 5.63



Fig. 5.64

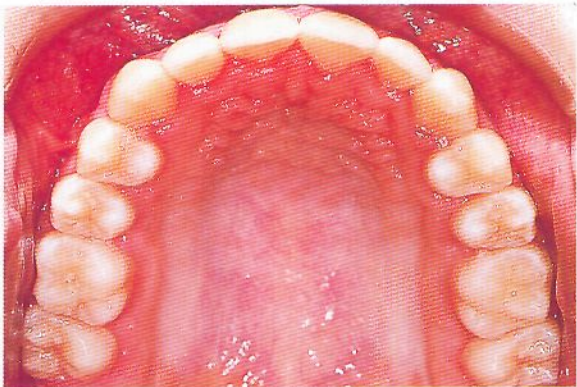


Fig. 5.66

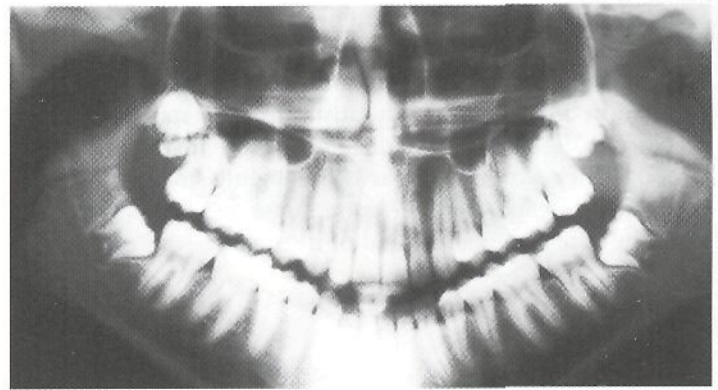


Fig. 5.67



Fig. 5.69

L.B. Final
15.1 years
1/25/00

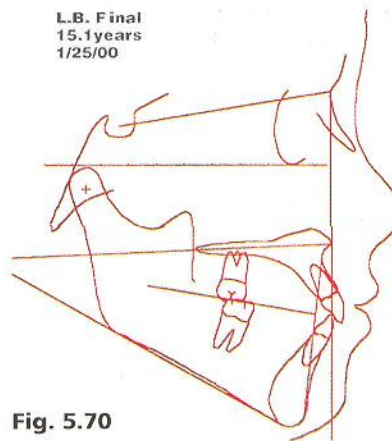
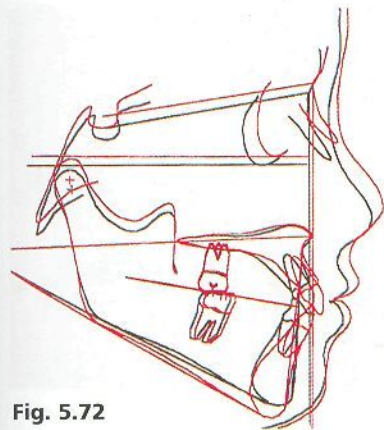


Fig. 5.70

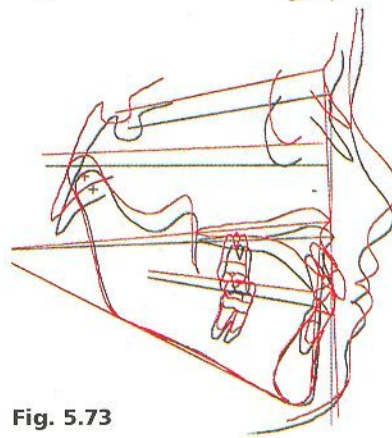
SNA / 77°
SNB / 76°
ANB / 1°
A-N FH -3 mm
Po-N FH -9 mm
WITS -4 mm
GoGnSN / 39°
FM / 29°
MM / 32°
1 to A-Po 9 mm
1 to A-Po 6 mm
1 to Max Plane / 114°
1 to Mand Plane / 88°



Palatal Plane &
Palate Curvature

L.B.Begin
L.B.Final

Fig. 5.72



Mand. Symphysis
& Mand. Plane

L.B.Begin
L.B.Final

Fig. 5.73

CASE JN

A male patient, aged 13.6 years at the start of treatment, with MM angle 31° and Class I dental bases.

Dentally, there was anterior and posterior crowding, with large third molars developing. Arch form was assessed as ovoid. It was felt that extraction of four premolars would be required in order to achieve a satisfactory and stable result in this case. A decision was made to extract the first premolars; although the second premolars were slightly small, they were consistently so and therefore good upper and lower tooth fit could be anticipated at the end of treatment.

The treatment was managed as a maximum anchorage case, and standard metal brackets were used for optimal control. Lacebacks and bendbacks were used in all four quadrants, with a lower lingual arch and an upper palatal bar to restrict molar movement during tooth alignment. Upper archwire was .016 HANT. Lower archwire was .015 multistrand, with offset bends for the buccally placed lower canines. The upper left canine bracket was lassoed with a module.

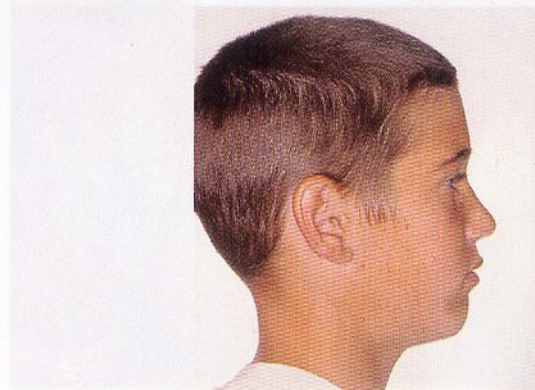


Fig. 5.74

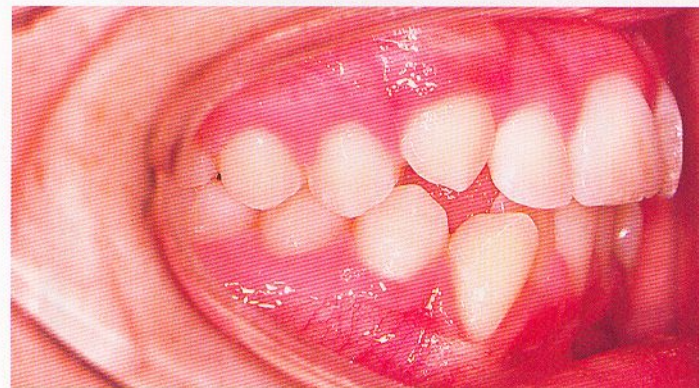


Fig. 5.77

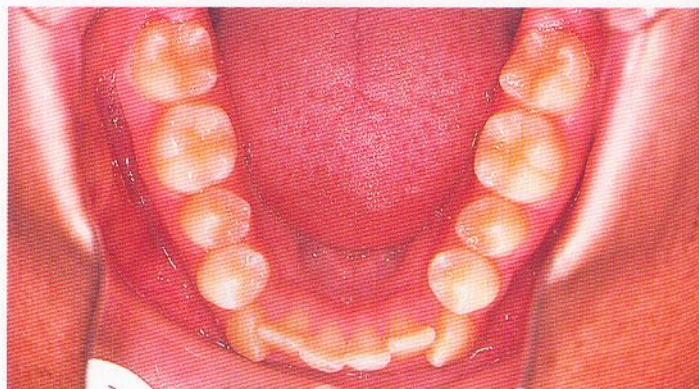


Fig. 5.80



Fig. 5.83



Fig. 5.75

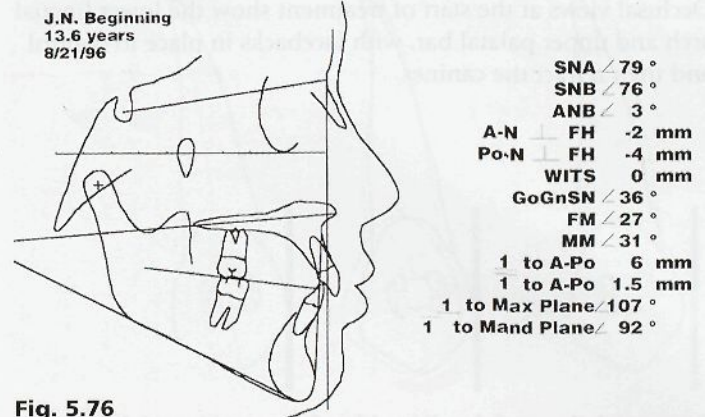


Fig. 5.76



Fig. 5.78

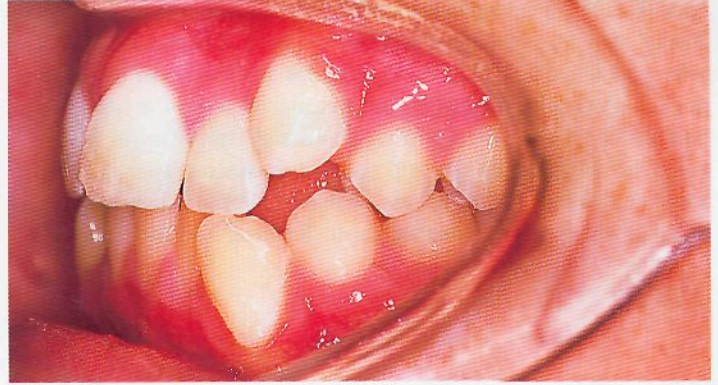


Fig. 5.79

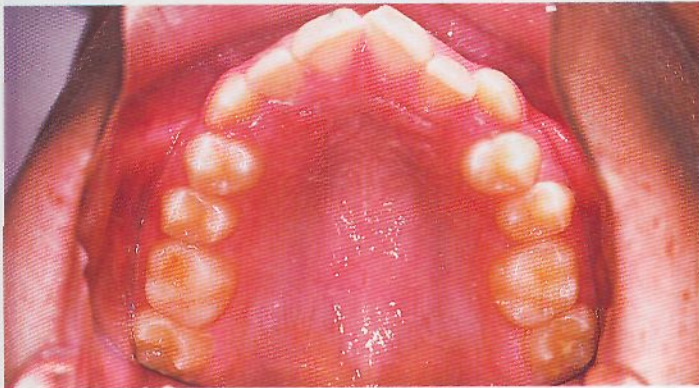


Fig. 5.81

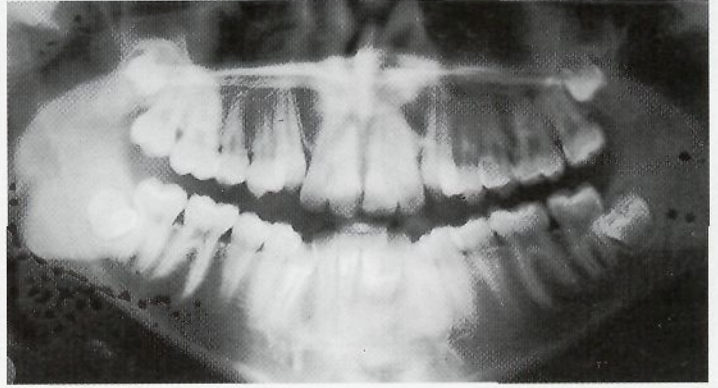


Fig. 5.82

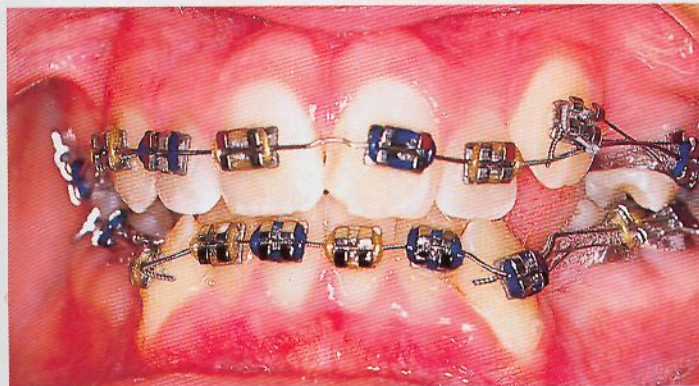


Fig. 5.84

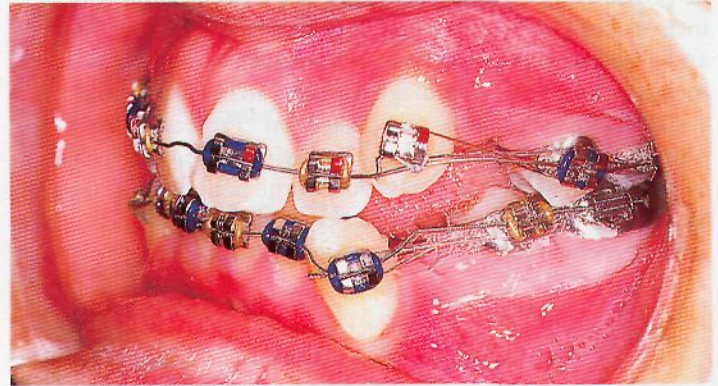


Fig. 5.85

Occlusal views at the start of treatment show the lower lingual arch and upper palatal bar, with lacebacks in place to control and then retract the canines.

Sequential views of the right side of the case 2 months, 4 months, and 6 months into treatment. In the upper arch, the initial .016 HANT wire was followed by a rectangular HANT wire and then a .019/.025 rectangular steel wire. In the lower arch, a rectangular HANT wire was placed after 4 months, and continued in use at 6 months. The lower right canine was retracted with lacebacks, and the upper canine simultaneously moved distally (p. 101). This provided a small amount of additional anchorage during tooth leveling and aligning.

After 9 months of treatment, upper and lower steel rectangular wires are in place and space closure is continuing.

Occlusal view at 9 months. Full upper space closure will not be possible until more palatal root torque of the upper incisors has been achieved (p. 284). During tooth leveling and aligning, it is convenient to have a checklist which includes lacebacks, anchorage support, archwire size and engagement, bendbacks, and protection. 'Protection' refers to protection of the appliance and archwires in the early stages of treatment, as well as protection of the patient's soft tissues from sharp aspects of the appliance, such as distal ends of the archwire which have not been properly turned in.

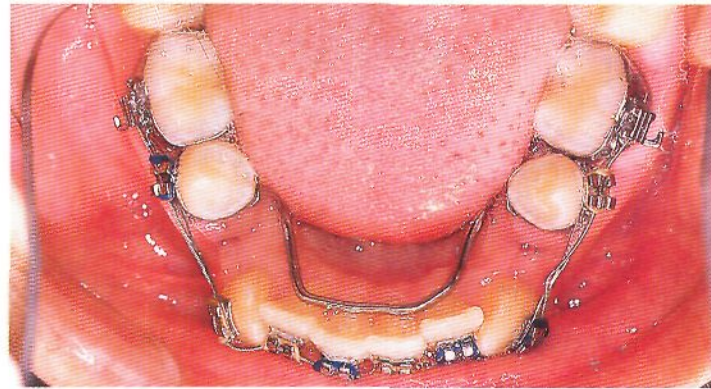


Fig. 5.86

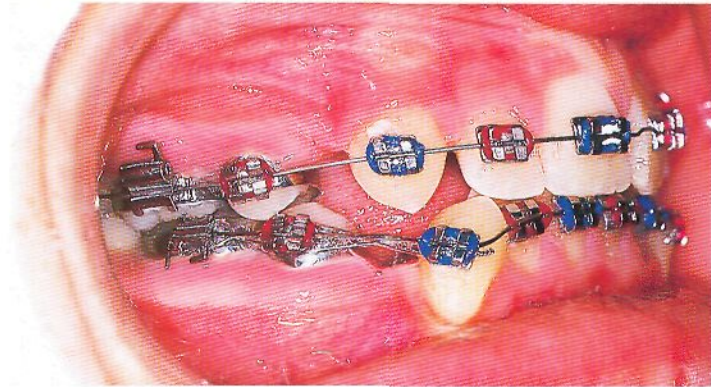


Fig. 5.89

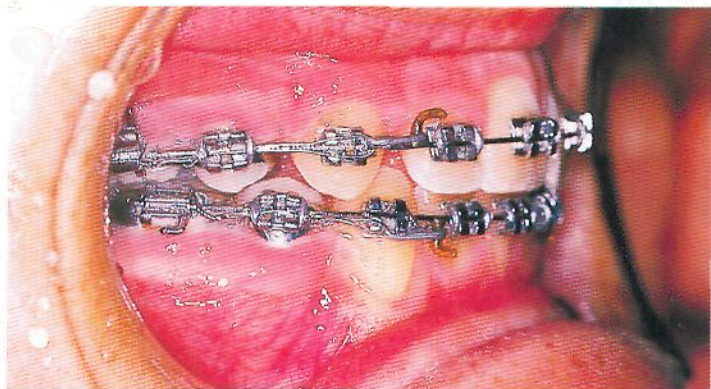


Fig. 5.92

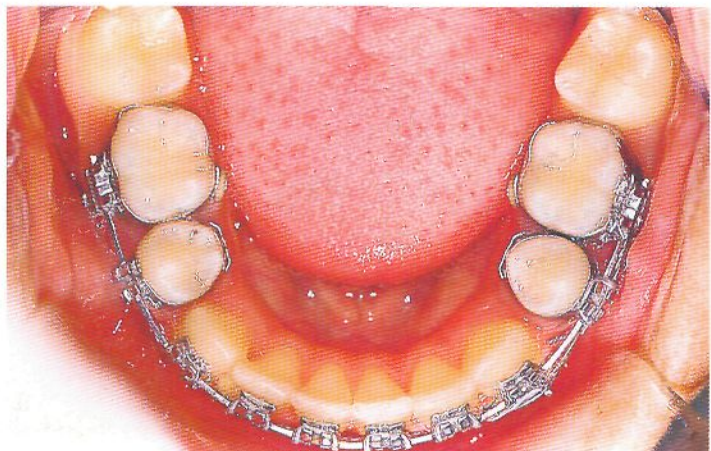


Fig. 5.95

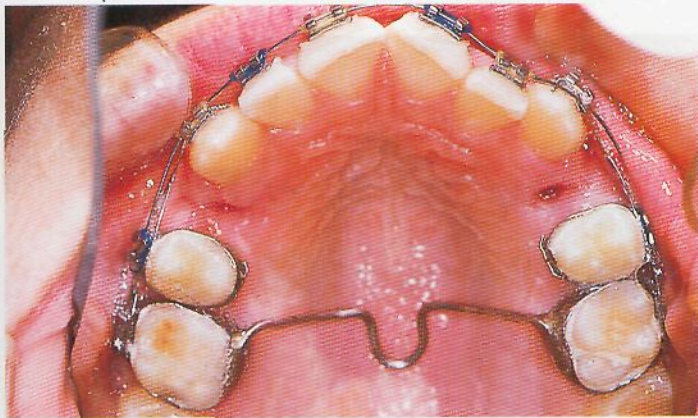


Fig. 5.87



Fig. 5.90

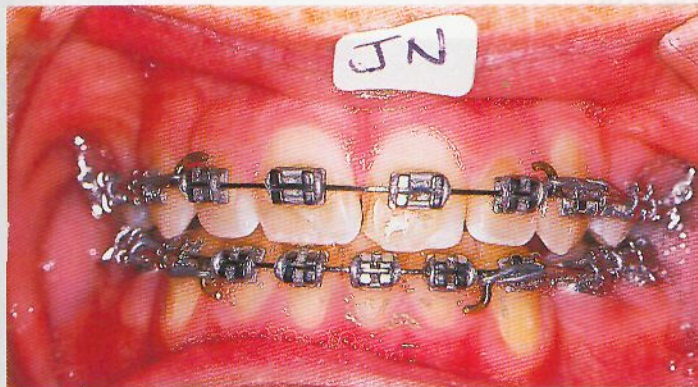


Fig. 5.93

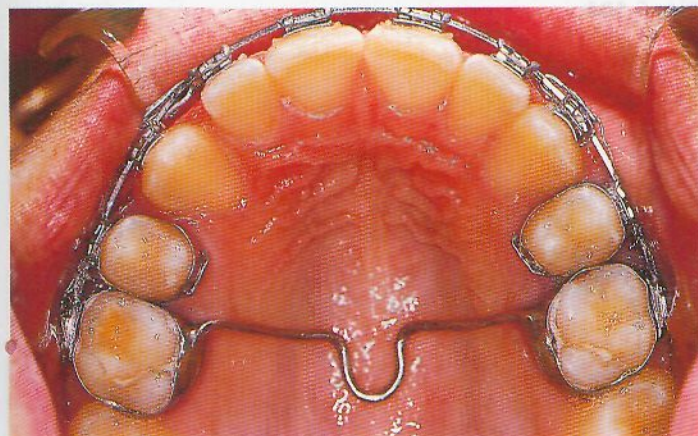


Fig. 5.96

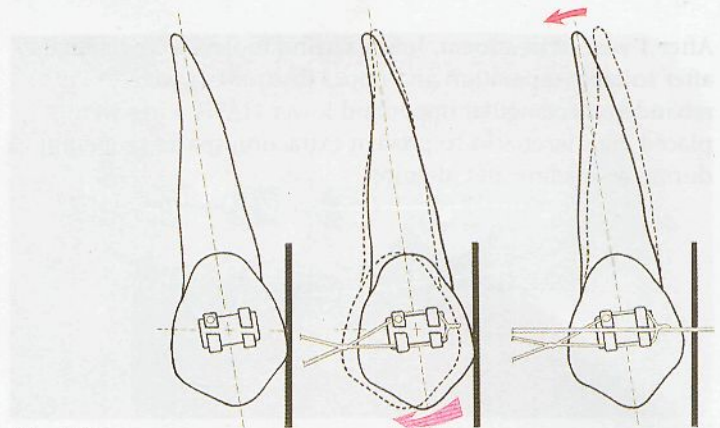


Fig. 5.88

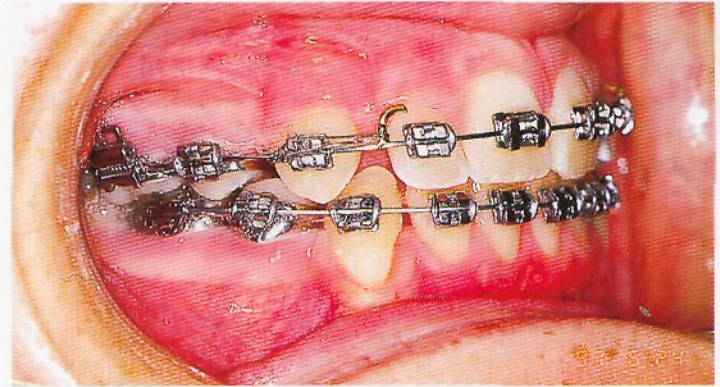


Fig. 5.91

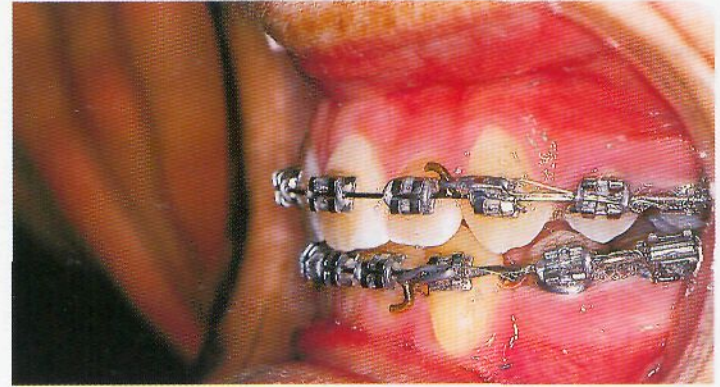


Fig. 5.94

LEVELING AND ALIGNING check list

- Lacebacks
- Anchorage support
- Archwire size and engagement
- Bendbacks
- Protection

Fig. 5.97

scanned by UST team

After 1 year of treatment, lower second molars were banded after suitable separation and upper first molars were rebanded. Rectangular upper and lower HANT wires were placed with lacebacks to prevent extraction spaces reopening during re-leveling and aligning.

Occlusal views 12 months into treatment show the need to correct the position of the lower left second molar. Rectangular HANT wires are very effective in achieving tooth movements of this type in this region. They give good control and do not distort in response to masticatory forces.

The case after 16 months of treatment. Normal upper and lower rectangular steel wires are in place and upper incisor torque is improving. Upper anterior teeth were tied with .010 wire ligatures to obtain full expression of the bracket system (p. 20).

After 19 months of treatment, settling was commenced using .014 round wires in both arches and up-and-down elastics. The patient was checked at 2-weekly intervals for approximately 6 weeks.

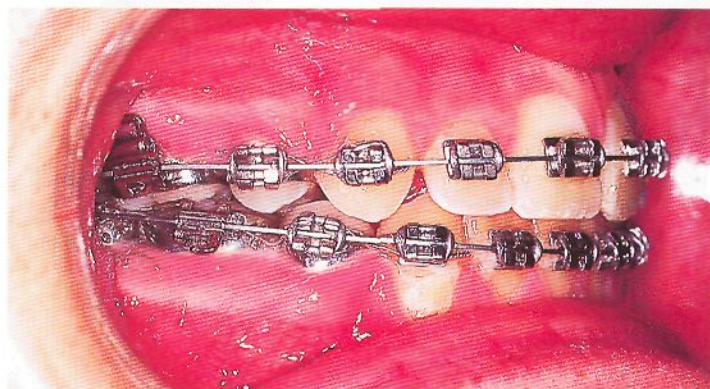


Fig. 5.98

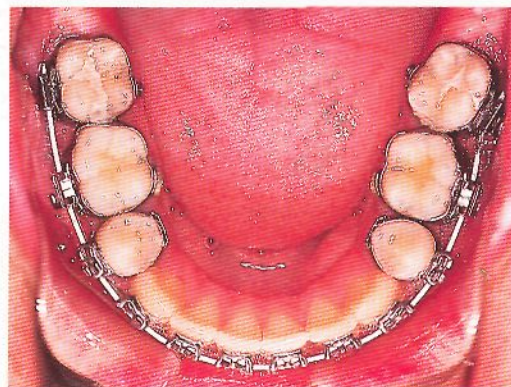


Fig. 5.101

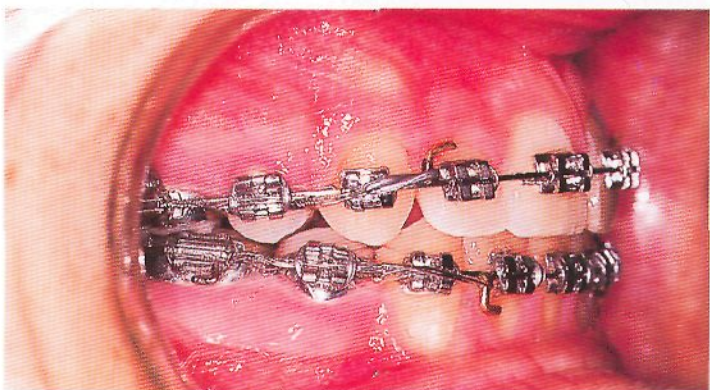


Fig. 5.104

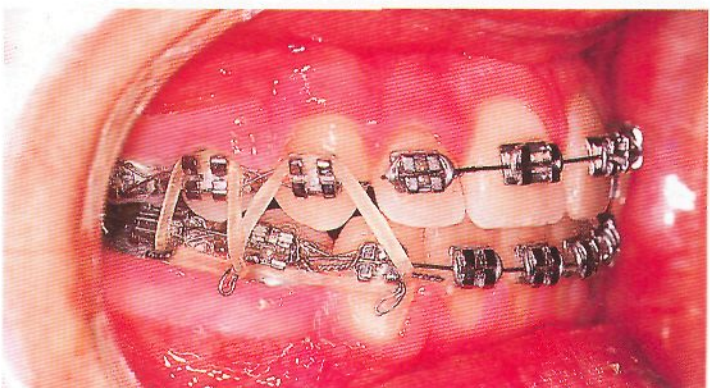


Fig. 5.107



Fig. 5.99



Fig. 5.100

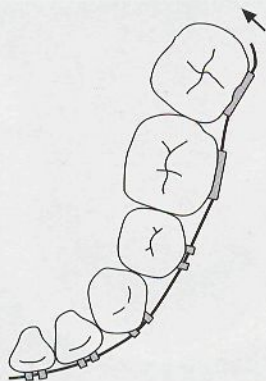


Fig. 5.102

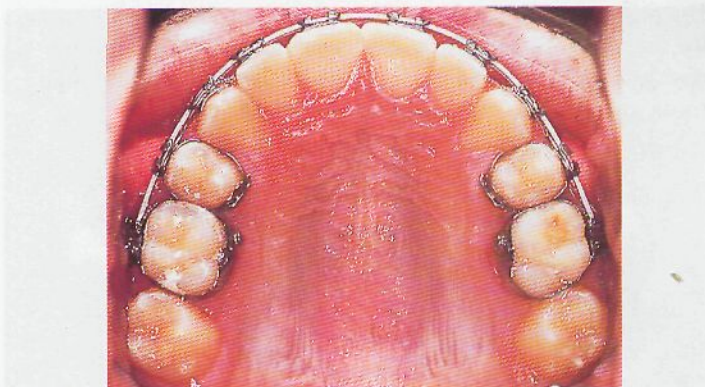


Fig. 5.103

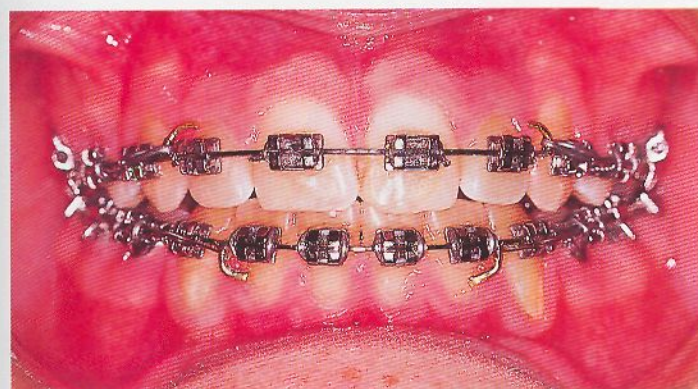


Fig. 5.105

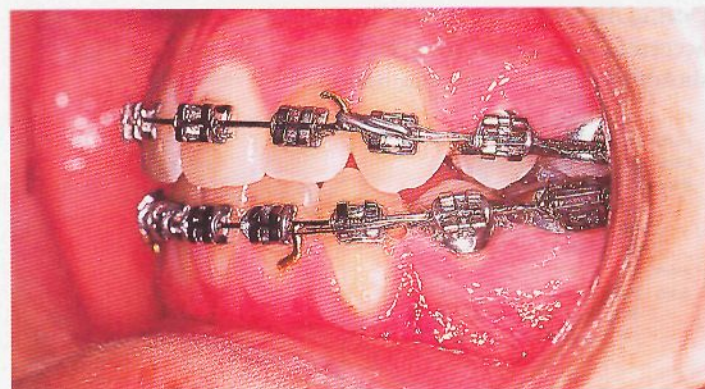


Fig. 5.106



Fig. 5.108

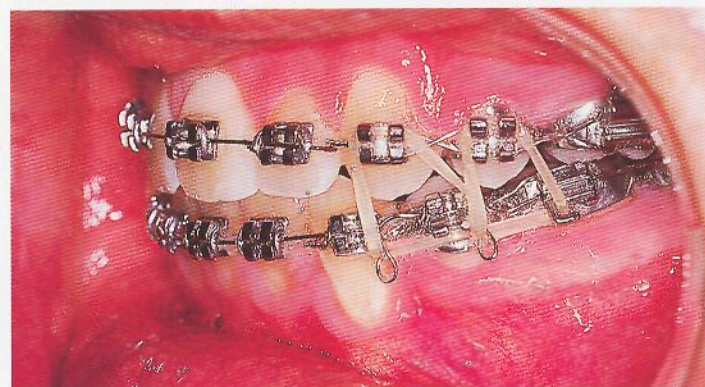


Fig. 5.109

The case after removal of appliances. Active treatment time was 22 months and conventional retainers were used, with the lower bonded retainer extended onto the lower second premolars to prevent lower extraction spaces reopening.

The panoramic radiograph confirms that there is adequate space for the developing third molars, and that the upper canine root positions are favorable, relative to the second premolar roots, owing to the 8° of tip in the canine brackets.

During the treatment period, considerable Class III growth occurred, with a final ANB angle of 1° . The facial profile shows pleasing balance and harmony.



Fig. 5.110

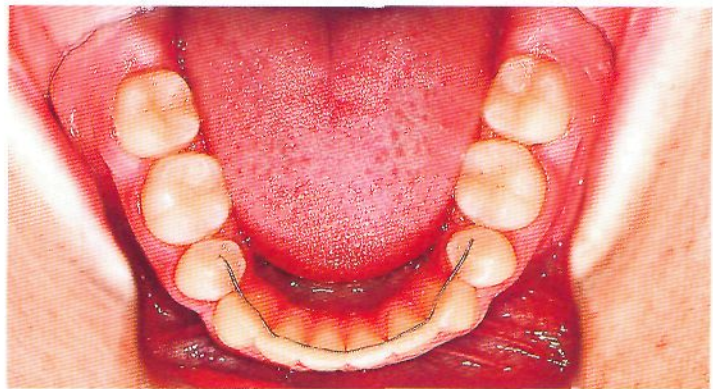


Fig. 5.113

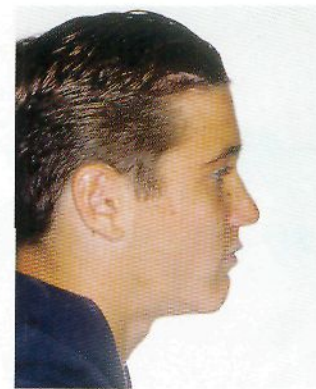
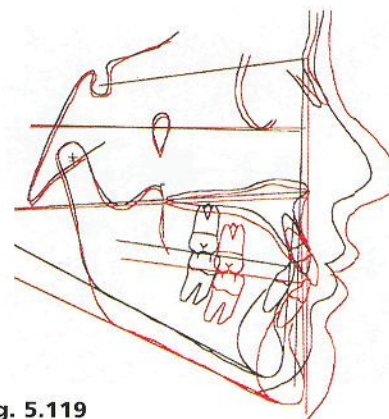


Fig. 5.116



SN at S

**J.N. Begin
J.N. Final**

Fig. 5.119

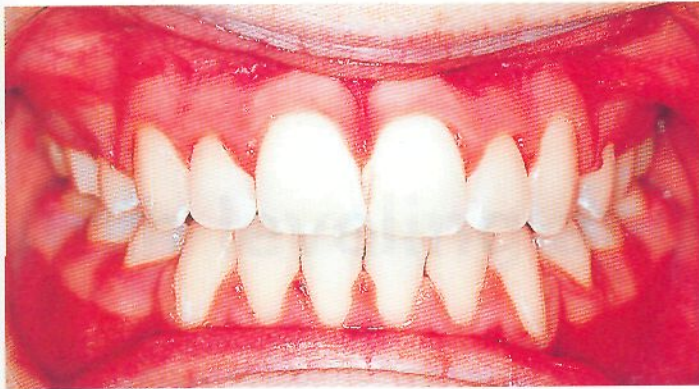


Fig. 5.111



Fig. 5.112

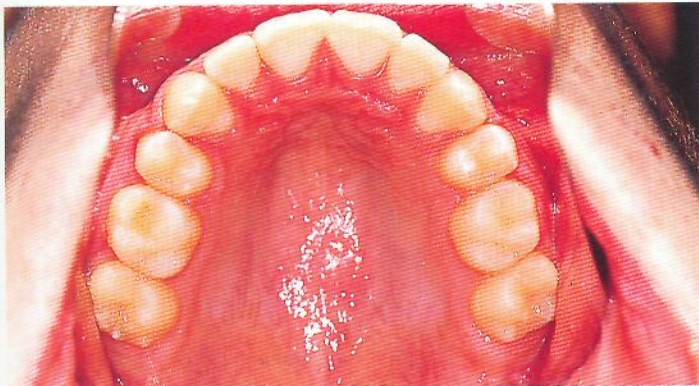


Fig. 5.114

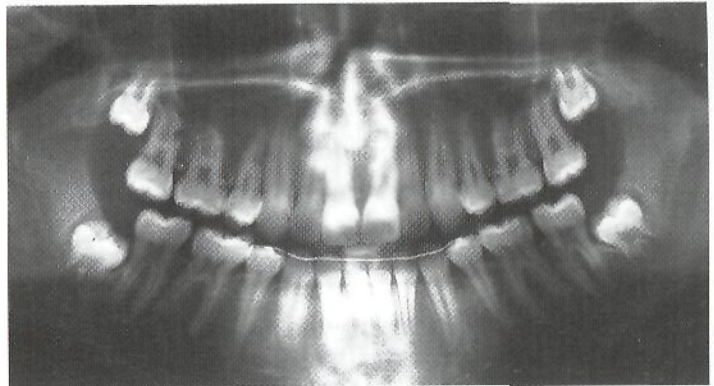


Fig. 5.115



Fig. 5.117

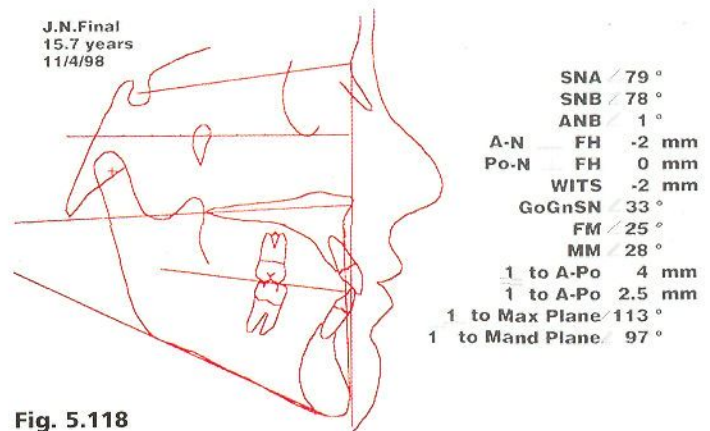
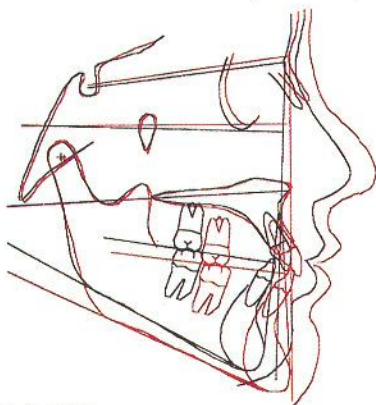


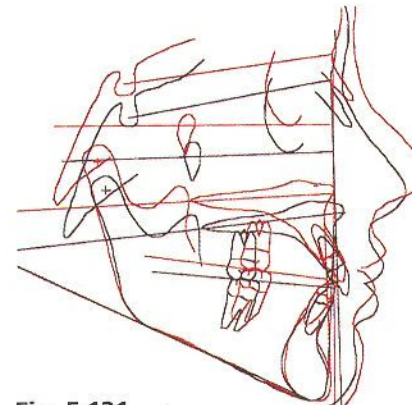
Fig. 5.118



**Palatal Plane &
Palate Curvature**

**J.N. Begin
J.N. Final**

Fig. 5.120



**Mand. Symphysis
& Mand. Plane**

**J.N. Begin
J.N. Final**

Fig. 5.121

CHAPTER 6

Arch leveling and overbite control

Introduction 131

The development of deep overbite 131

The tooth movements of bite opening 132

Eruption/extrusion of posterior teeth 132

Distal tipping of posterior teeth 133

Proclination of incisors 133

Intrusion of anterior teeth 133

Non-extraction treatment 134

Initial archwire placement 134

The bite-plate effect 134

Creating the bite-plate effect 135

The importance of second molars 136

Torque issues 136

Bite-opening curves 137

Antero-posterior issues and elastics 138

Spacing in non-extraction cases 138

Extraction treatment 138

Light forces during leveling and aligning 139

Light forces during space closure 141

The development of anterior open bite 142

Early management of open bites 143

Management of anterior open bite during full orthodontic treatment 144

Case MP A maximum anchorage deep bite case with extraction of four first premolars 146

Case CW A deep bite non-extraction treatment 152

INTRODUCTION

In the authors' previous text, overbite control was discussed in a separate chapter, following the subject of tooth leveling and aligning. However, it has become apparent, especially with the use of heat-activated nickel-titanium (HANT) wires, that overbite control is more closely related to the arch leveling process, and that it generally occurs after the leveling and aligning of individual teeth. For example, many cases show well-aligned teeth in the early part of treatment, but still have a significant amount of deep overbite, with arches that are not level. This chapter will review deep overbite in non-extraction and extraction cases, and will discuss the general principles involved in the management of anterior open bite.

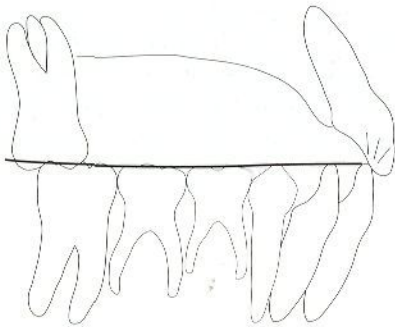


Fig. 6.1 Lower anterior teeth normally erupt until contact is made with upper anterior teeth.

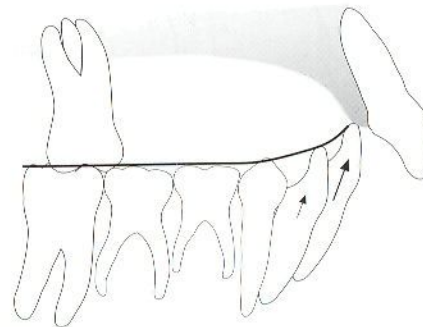


Fig. 6.2 If the molar relationship is Class II, the lower incisors can erupt until they contact the palate. This can cause a steep anterior curve of Spee.

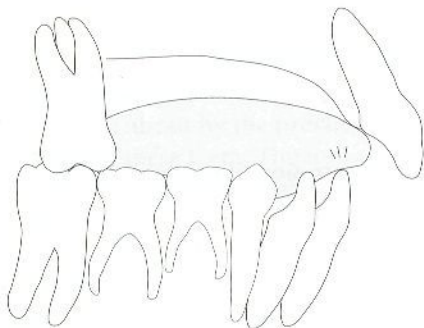


Fig. 6.3 The tongue can restrict over-eruption of lower incisors in some Class II cases.

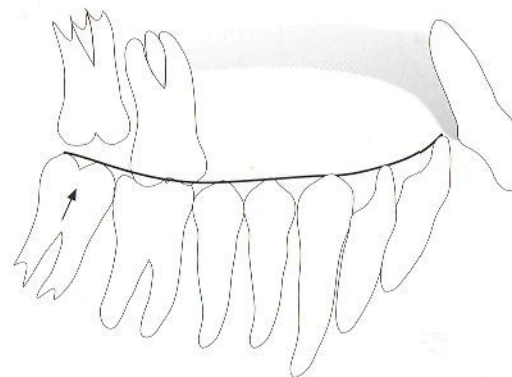


Fig. 6.4 Unrestricted eruption of lower second molars in a Class II case contributes to development of the posterior part of the curve of Spee.

THE TOOTH MOVEMENTS OF BITE OPENING

The correction of deep overbite involves reversing the above process, and is accomplished by various tooth movements, including the following:

- Eruption/extrusion of posterior teeth (Fig. 6.5)
- Distal tipping of posterior teeth (Fig. 6.6)
- Proclination of incisors (Fig. 6.7)
- Intrusion of incisors (Fig. 6.8)
- A combination of two or more of the above tooth movements.

Eruption/extrusion of posterior teeth

The eruption of posterior teeth is a normal vertical molar change in a growing individual. It is a stable process that accompanies vertical facial development.

The normal eruption of posterior teeth is a contributing factor in achieving bite opening in deep-bite patients (Fig 6.5). The increase in vertical facial height in growing patients also accommodates the extrusion of posterior teeth that can occur during orthodontic treatment, when leveling of the curve of Spee and using inter-maxillary elastics (Class II, Class III, and vertical).

However, the extrusion of posterior teeth in adults with average to low mandibular plane angles is not a stable process. The musculature generally resists this extrusion and by the end of treatment, or shortly after, the molars return to their original vertical position and the mandibular plane returns to its original position. This may become a source of post-orthodontic relapse and return of the deep overbite. In high-angle adult patients with weaker musculature, orthodontic extrusion of posterior teeth may remain stable at the end of treatment, with permanent opening of the mandibular plane. This is undesirable in most high-angle cases.

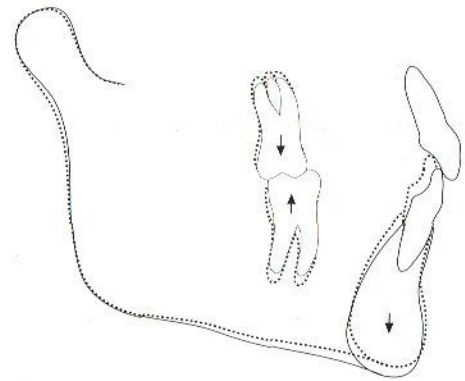


Fig. 6.5 Eruption/extrusion of posterior teeth.

Distal tipping of posterior teeth

This is normally a stable process in the growing patient, as it is accommodated by the increase in vertical facial height. However, in most average- to low-angle adult cases, distal tipping of posterior teeth is not stable, because it will be followed by intrusion of these teeth to the original vertical dimension. This may not occur during orthodontic treatment but will normally follow shortly after, and can be a source of post-orthodontic relapse of the deep bite. In the adult high-angle patient, the distal tipping of posterior teeth may lead to some permanent opening of the mandibular plane and is to be avoided. Sometimes the equilibration of posterior teeth after distal tipping is beneficial in these high-angle adult cases (Fig. 6.6).

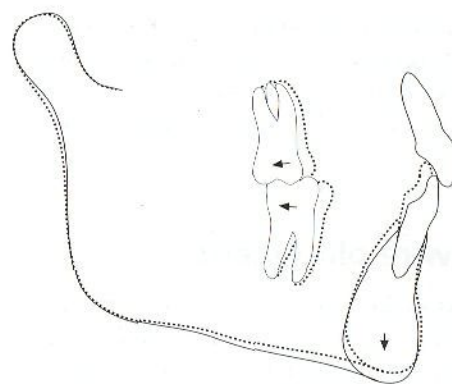


Fig. 6.6 Distal tipping of posterior teeth.

Proclination of incisors

Numerous deep-bite cases present with retroclined incisors, and proclination of these teeth contributes to bite opening in the anterior area. In the lower arch, this generally consists of lower incisor crowns being proclined. In the upper arch, a combination of crown proclination and root torque control normally occurs, with roots moving distally in the bone (Fig. 6.7).

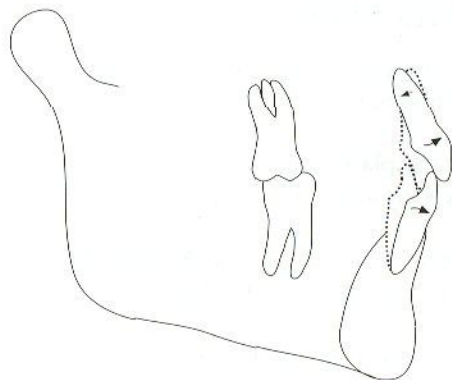


Fig. 6.7 Proclination of incisors.

Intrusion of anterior teeth

In the majority of treatments for growing patients, intrusion of anterior teeth is normally not required. As the face grows vertically, preventing or even restricting the normal eruption of these anterior teeth will essentially allow the bite to 'grow open' as posterior eruption, extrusion, and/or distal tipping occur.

This is not true in adult cases, where the musculature resists these posterior changes. Therefore, bite opening in adults must be brought about by the proclination of incisors and/or the intrusion of these teeth. The intrusion of anterior teeth in these adult cases can be brought about with full arch treatment, but the process occurs slowly. Therefore, the use of supplemental intrusion arches, as advocated by Ricketts or Burstone, may assist the incisor intrusion process which is required for these adult patients (Fig. 6.8).

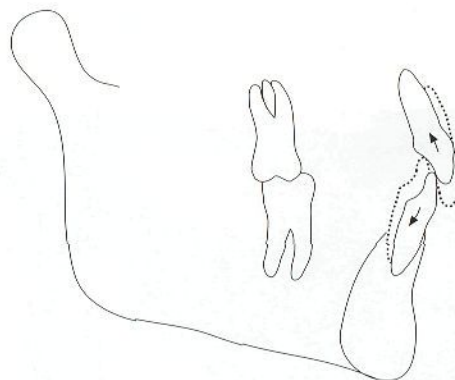


Fig. 6.8 Intrusion of anterior teeth.

NON-EXTRACTION TREATMENT

Non-extraction treatment generally favors bite opening. This is because distal tipping of posterior teeth and proclination of incisors normally occurs in these cases. There are a number of mechanical factors that lead to arch leveling and control of the deep overbite:

Initial archwire placement

When flat archwires are placed into dental arches with curves of Spee, the archwires attempt to return to their original shape and this starts the bite-opening process. Also, expression of the tip in the brackets begins the bite-opening process.

The bite-plate effect

Introducing the bite-plate effect (Fig. 6.9) in deep-bite cases is helpful in the bite-opening process in three ways:

1. It allows for early placement of brackets on lower incisors, which begins their movement.
2. Anterior bite plates can produce an intrusive force on lower incisors which limits any future extrusion of these teeth.
3. Anterior bite plates allow for the eruption, extrusion, and/or uprighting of posterior teeth.

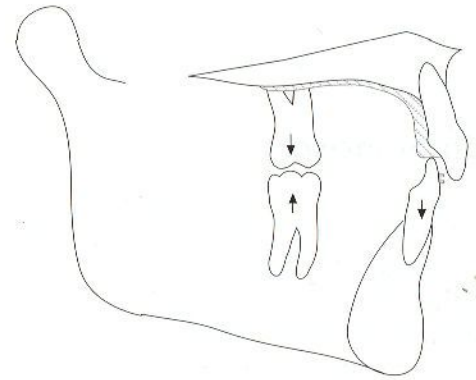


Fig. 6.9 The bite-plate effect is helpful in the bite-opening process.

Creating the bite-plate effect

There are four methods of creating the bite-plate effect:

1. Appliances can be placed on the upper arch only, which allows for proclination of the upper incisors (Fig. 6.10A). This frees the lower incisors for placement of brackets. This technique is helpful in high-angle cases, because posterior extrusion is minimized.
2. Acrylic removable anterior bite plates can be placed (Fig. 6.10B). This is particularly helpful in low-angle deep-bite cases, because it encourages distal tipping, eruption, and extrusion of molars. The disadvantage of these removable appliances is that they are not always worn by the patient. Also, tooth movements lead to improper fit of these appliances after a relatively short period of time.
3. An adequate substitute for a removable bite plate in low-angle deep-bite cases is the placement of direct bonding material on the palatal surface of the upper incisors (Fig. 6.11). Colored adhesives such as Bandlock™ from Reliance or Transbond Plus™ from 3M Unitek are useful and can be easily removed from the tooth surfaces after bite opening.
4. In average- to high-angle cases, the placement of similar colored adhesives on the occlusal surface of the first molars is helpful in bite opening (Fig. 6.12). This adhesive can be progressively removed as the bite opens. When first molars have restorations, it may be difficult to bond to the occlusal surface of these teeth. Therefore, the second premolars or second molars can be used in such cases.

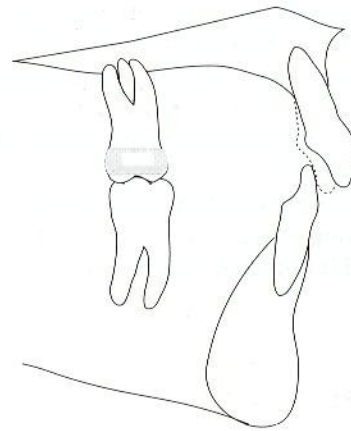


Fig. 6.10A Appliances may be placed on the upper arch only.

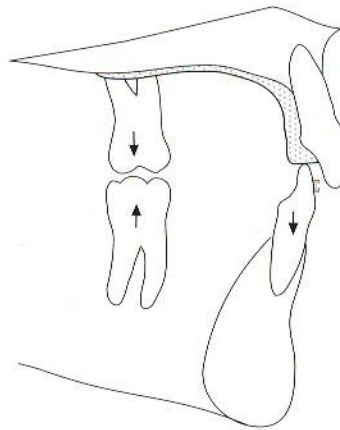


Fig. 6.10B Acrylic removable bite plate.

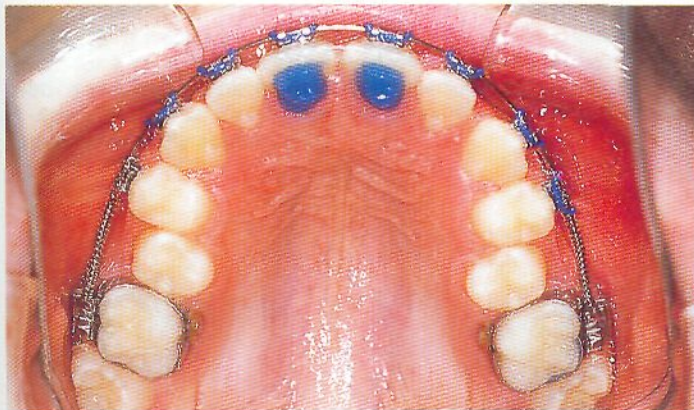


Fig. 6.11 Direct bonding material on the palatal aspect of upper incisors.



Fig. 6.12 Blue colored direct bonding material on the occlusal surfaces of lower first molars.

The importance of second molars

In average- to low-angle deep-bite cases, the earliest possible banding or bonding of the second molars, especially the lower second molars, is most beneficial in bite opening. Inclusion of the second molars provides an excellent lever arm for eruption or extrusion of the premolars and first molars, and assists in incisor intrusion (Fig. 6.13). In numerous cases, the authors have observed that complete bite opening and leveling of the curve of Spee in the lower arch is extremely difficult if the lower second molars are not included (Fig. 6.14).

Torque issues

There is a tendency to believe that torque is introduced into the dentition by rectangular wires only, but this is not so.

During early leveling procedures with round wires, torque changes occur, especially among anterior teeth. These actually begin to produce favorable torque changes in the case, before placement of rectangular wires. The flexibility of HANT wires allows for early placement. This allows earlier torque control than was possible when only steel wires were available.

Rectangular steel .019/.025 wires typically follow the rectangular HANT wires (p. 111). These rectangular steel wires are normally placed flat, without introducing torquing bends or any archwire curves. After they have been in place for at least 6 weeks, torque bends and archwire curves can be added to rectangular steel wires as necessary. Up to 20° of palatal root torque can be introduced into the upper wire in the incisor area, and 10° to 15° of labial root torque can be introduced into the incisor area of the lower wire (Fig. 6.15). These torque changes contribute to the bite-opening process.

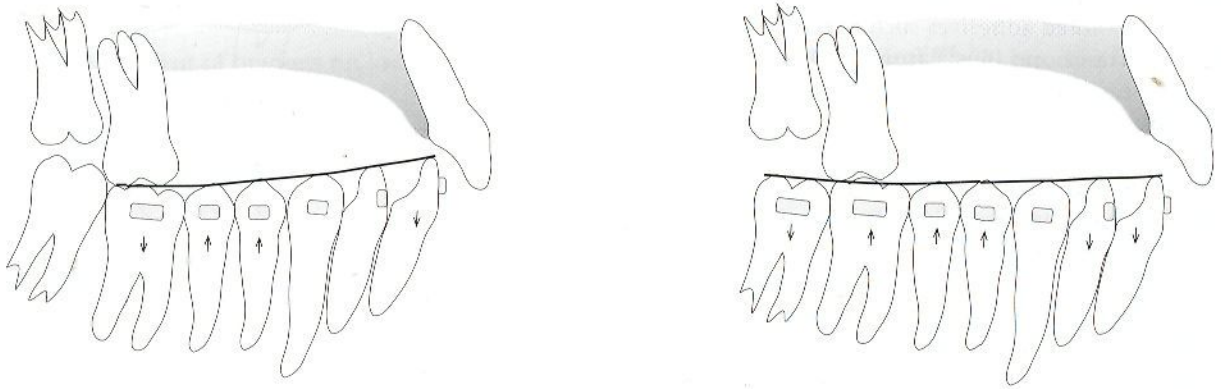


Fig. 6.13 Leveling of the curve of Spee in the lower arch is difficult if the lower second molars are not included. Inclusion of the second molars assists in incisor intrusion and correction of the overbite, together with complete leveling of the curve of Spee.



Fig. 6.14 Lower second molars are not included in this case, and complete bite opening and leveling of the curve of Spee have not occurred.

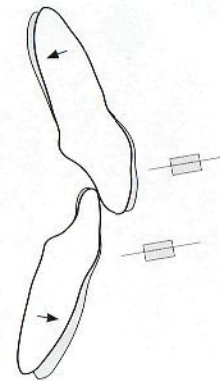


Fig. 6.15 Rectangular steel wires are normally placed flat. After they have been in place for at least 6 weeks, upper palatal root torque and lower labial root torque can be introduced into the wires, as shown above.

Bite-opening curves

The authors prefer not to place bite-opening curves in round wires or to have such curves built into rectangular heat-activated wires. They accept the fact that such wires do not complete the leveling of the arches and the bite-opening process. In the great majority of cases after rectangular stainless steel wires have been in place for 6 weeks, the arches are normally level and adequate bite opening has been achieved. If this is not so, then bite-opening curves can be placed into the rectangular steel wires.

Placing a bite-opening curve in the upper archwire increases palatal root torque to the upper incisors. This is

beneficial in the majority of cases and it is usually unnecessary to add any additional torque bends to this upper wire, but is sometimes needed (Fig. 7.185, p. 210).

When bite-opening or reverse curve is placed in the lower rectangular steel wire, the result is proclination of lower incisors. This is generally not indicated. Therefore, before placement of a bite-opening curve in the lower wire, approximately 10° to 15° of labial root torque can be added. After this, bite-opening curves can be placed and the net effect will be a retroclining and intrusive force on the lower incisors (Fig. 6.16).

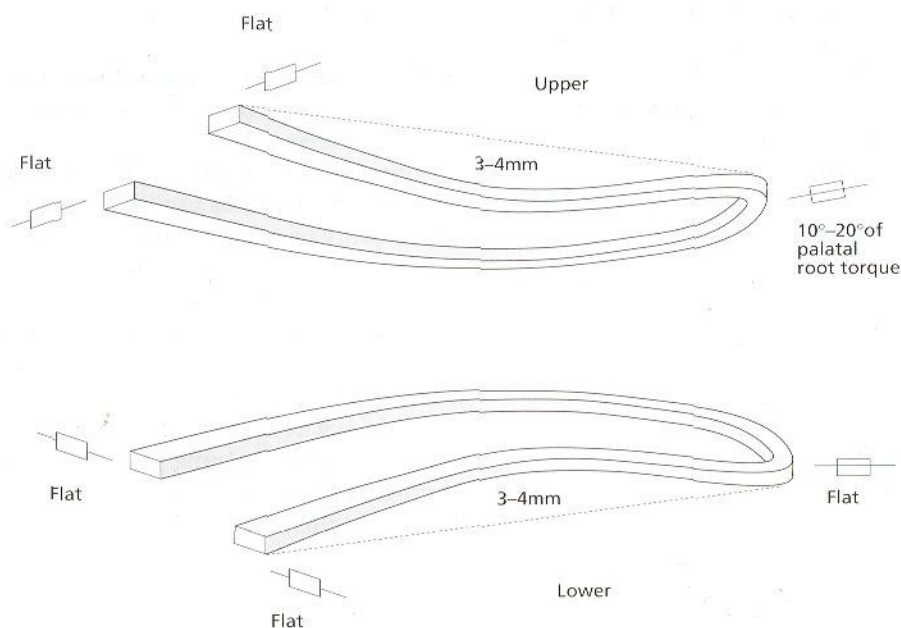


Fig. 6.16 If necessary, bite-opening curves can be placed in upper and lower rectangular steel wires after the wires have been in place for 1 or 2 months. The lower wire needs to be flat (no torque) in the incisal region to prevent proclination of lower incisors. Both archwires are normally flat (no torque) in the molar regions, unless there is a need for molar torque changes. Approximately 3-4 mm of reverse curve is appropriate if the second molars are included. If the second molars are not included, slightly less reverse curve is normally appropriate.

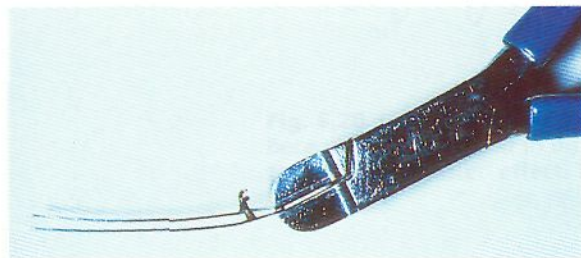


Fig. 6.17

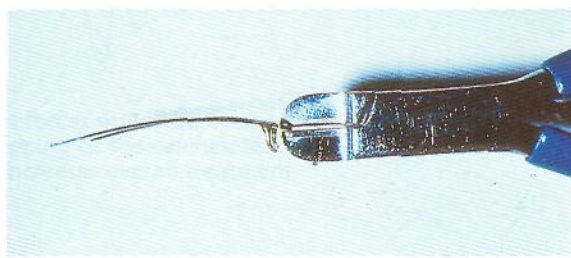


Fig. 6.18

Antero-posterior issues and elastics

Class II or Class III inter-maxillary elastics are often used to correct antero-posterior problems, and it is recommended that rectangular stainless steel wires should be in place when they are used. Inter-maxillary elastics can contribute to the bite-opening effect by assisting in the extrusion of molars as the A/P problem is corrected (Fig. 6.19). They are beneficial in the treatment of most growing patients. If possible they should be avoided in most non-growing and adult high-angle cases.

Spacing in non-extraction cases

Non-extraction cases normally do not show significant amounts of spacing. When spaces occur, they can generally be closed without difficulty with the use of tiebacks as described in the space closure chapter (p. 254). This can be accomplished after leveling and bite-opening procedures.

Space closure should not be attempted until full bite opening and leveling has been achieved.

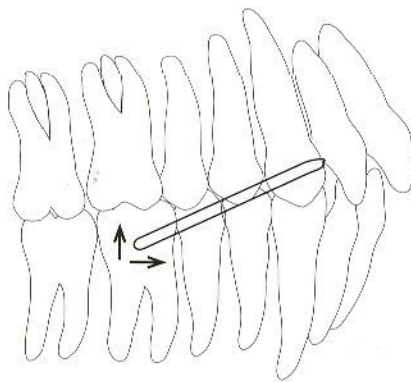


Fig. 6.19 Class II inter-maxillary elastics can contribute to the bite-opening effect.

EXTRACTION TREATMENT

Most of the mechanical treatment procedures described for deep-bite non-extraction cases also apply to deep-bite extraction cases. These include the effects of archwire deflection, tip in the brackets, the use of bite-plate effect, the banding of second molars, the torquing effect of rectangular wires, the effect of bite-opening curves in rectangular wires, and the effects of inter-maxillary elastics.

However, there are two other important factors in extraction deep-bite cases:

- With extraction cases, lower incisors are normally maintained in their position or brought to a more retroclined position. This makes the bite opening more difficult.
- If space closure is attempted before proper arch leveling and overbite control, it will lead to bite deepening.

One of the great advantages of the preadjusted appliance system is the ability to use sliding mechanics. For this reason, the majority of orthodontists are using sliding mechanics as opposed to closing loop arches. In order to effectively slide a rectangular wire through posterior bracket slots, it is necessary for these segments to be free of friction. It is therefore important to complete arch leveling and overbite control before starting space closure. This will minimize friction. When arch wires are in a deflective state due to incomplete leveling and bite opening, they cannot effectively slide through the posterior bracket slots during space closure, because of the friction.

www.allislam.net
Problem

Light forces during leveling and aligning

If premolars are extracted in deep-bite cases, it is normally to reduce anterior protrusion or eliminate anterior crowding, or a combination of the two. If there is anterior protrusion without crowding, it is possible to retract the anterior segments en masse. Alternatively, the canines can be retracted alone, followed by retraction of the incisors. If the latter decision is made, extreme care must be taken not to tip the cupids distally because this results in extrusion of the incisors and further bite deepening (Fig. 6.20). For this reason, the authors prefer to carry out en masse retraction of the anterior six teeth with a rectangular steel wire after arch leveling and overbite control.

In cases with anterior crowding, it is necessary to retract canines at least until there is enough space for proper incisor alignment. In the lower arch, this is the authors' preferred treatment method. After crowding has been eliminated in the lower incisor region and the case has been leveled to the rectangular steel wire stage, then en masse movement is carried out. In the upper arch, it is not only important to retract canines until crowding is eliminated, but also to

attempt to maintain a Class I canine relationship. Therefore, in certain cases, the canines may be retracted a greater distance to maintain this Class I position. This may result in some spacing mesial to the canines (Case JN, p. 123). It has been observed in many cases that the contact of the lower canine against the upper canine serves to distalize the upper canine. This additional source of anchorage is helpful in the overall management of the upper anterior segment. The upper arch can then be retracted en masse using rectangular stainless steel wires.

There is a tendency for incisors and canines to tip mesially after placement of the opening archwires, due to the built-in tip features of the preadjusted appliance system. Canine lacebacks (p. 15) should be used to resist this mesial tipping of the canines and to retract these teeth effectively without distal tipping. Elastic forces should be avoided, because they can result in excessive distal tipping of the canines. This can lead to posterior bite opening, and the overall reaction has been called the 'roller coaster' effect (Fig. 6.20), which increases overall treatment time.

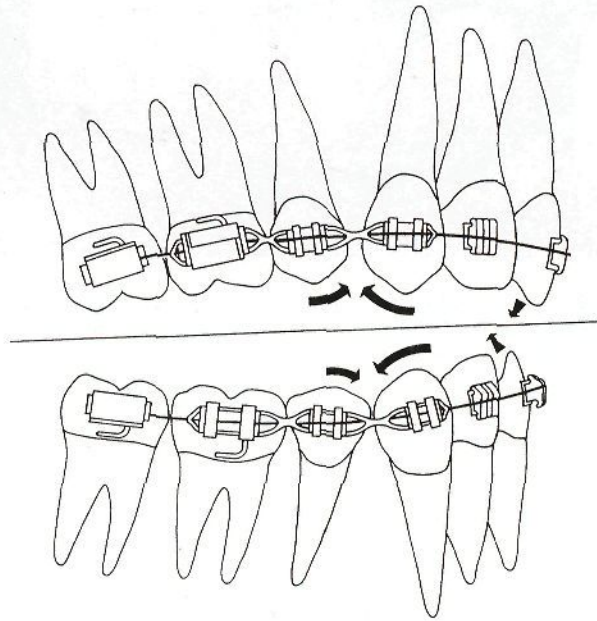


Fig. 6.20 Canine elastic retraction forces should be avoided because they can result in distal tipping of the canines, leading to the 'roller coaster' effect. This increases overall treatment time.

Lacebacks (p. 100) initially compress the periodontal ligament space on the distal aspect of the canine, leading to slight tipping. This is followed by adequate time for uprighting, in response to the leveling effect of the archwire. This uprighting occurs with a laceback, but it is not seen if elastic chains are used, because they give a continuous force which does not allow time for rebound to occur.

The discussion thus far has assumed a favorable initial position of the canines with the crowns at slight or moderate anterior inclination. However, if canines show unfavorable angulation at the start of treatment (Fig. 6.21), much greater care is needed to ensure good overbite control. Figure 6.22 shows how preadjusted brackets on unfavorably angled canines can cause unwanted extrusion of incisors after the initial archwires have been placed. The authors normally prefer to bracket the incisors that are in reasonably good alignment and include them in the initial archwires. This

provides greater stability to the arch form and minimizes distal tipping of the canines. However, when canines are unfavorably angled, it may be beneficial to avoid bracketing the incisors until the canine roots have been retracted, providing more favorable angulation of the canine slots. This method minimizes the inevitable tendency for bite deepening in such cases. An alternative technique involves placing a bend in the archwire, mesial to the canines, to prevent a slight intrusive force on the incisors while the canine roots are being moved distally.

In summary, it is clear that there are many factors which can lead to bite deepening during the initial leveling stage. Effective overbite control requires the use of light forces, with minimal activation and adequate rebound time. Lacebacks have proven to be the most effective way of controlling canine position and movement, and hence the overbite, in these cases.

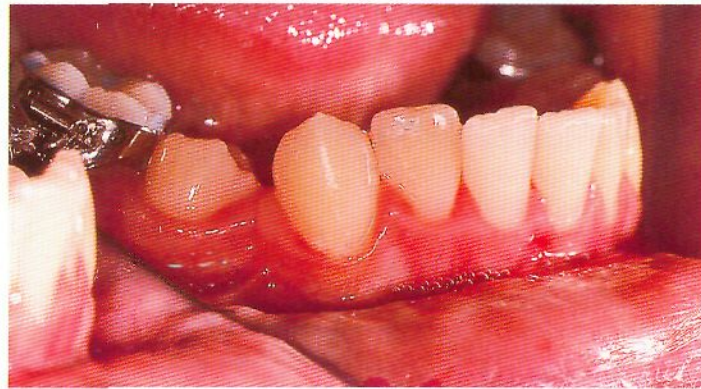


Fig. 6.21 Unfavorable distal tipping of the lower canines at the start of treatment. Greater care and time will be required to ensure good overbite control.

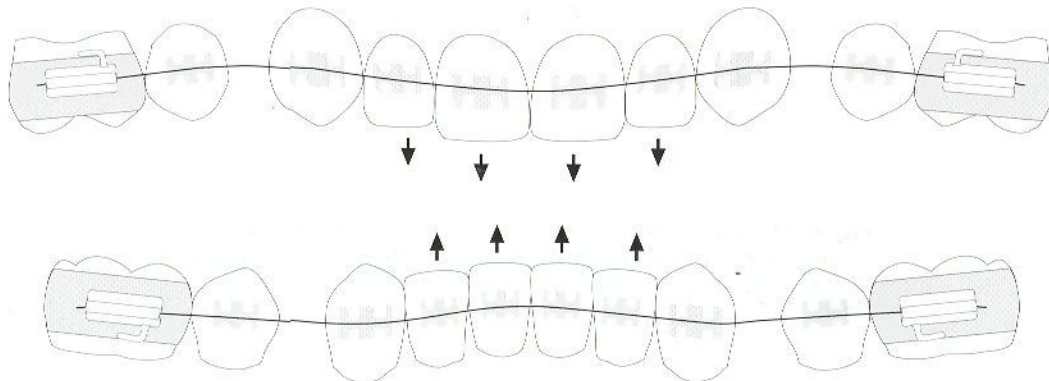


Fig. 6.22 Unfavorably angled canines can cause unwanted extrusion of the incisors after placement of the initial archwires.

Light forces during space closure

It is important to use light force levels during the stage of space closure. Heavy forces can cause the bite to deepen in two ways:

- The canines can tip into the extraction sites causing archwire deflection and binding. The sliding mechanics then become ineffective, and the overbite deepens.
- Excessive force overpowers the incisor torque control of the rectangular wire (Fig. 6.23), particularly in the upper arch, causing distal tipping and bite deepening.

A small amount of torque added to the upper archwire in the incisor region, combined with lighter forces, is usually effective in minimizing these two bite-deepening factors.

The authors have tried various force levels during space closure and feel that a range of 150–200 gm is most effective. This minimizes any tendency to unwanted bite deepening, and allows for efficient sliding mechanics and space closure. Active tiebacks (pp 256 & 257) are used to deliver a force of this size.

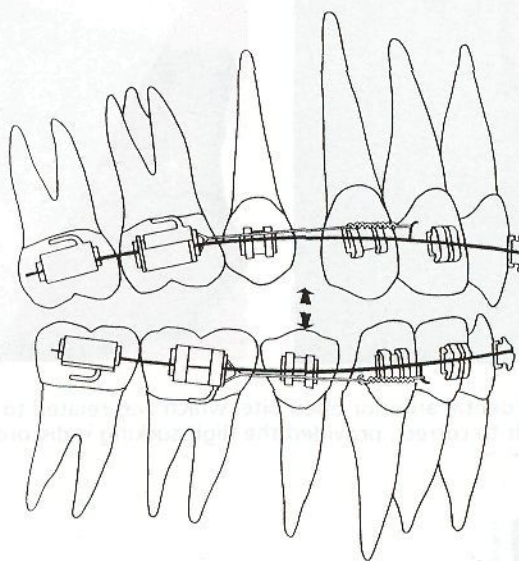


Fig. 6.23 Excessive force during space closure can cause distal tipping and bite deepening.

THE DEVELOPMENT OF ANTERIOR OPEN BITE

Anterior open bite can develop as a result of genetic and/or environmental factors. Environmental factors include finger and thumb habits (Fig. 6.24), tongue posturing and thrusting problems, and respiratory concerns related to conditions such as allergies, adenoids and tonsils, and mouth breathing.

Genetic factors can contribute to anterior open bite in the following manner. If patients show an excess of anterior vertical facial growth relative to posterior vertical facial growth, they are more prone to anterior open bite. These 'high-angle' cases frequently show a steep mandibular plane angle and a long lower facial height. Such cases are referred to

as skeletal open bites, and are most difficult to treat orthodontically, because correction normally requires considerable eruption and torquing of incisors.

On the other hand, if patients have an average or short lower facial height (average- to low-angle cases) (Fig. 6.25), although environmental factors may lead to an anterior open bite, they are usually much easier to treat. Elimination of the causative factors allows rapid bite closure, since significant eruption and torquing of the incisors are not required. Such cases are referred to as dental open bites and can be corrected with little difficulty by eliminating the environmental factors.



Fig. 6.24 This patient had an asymmetrical dental anterior open bite, which was related to right thumb sucking activity. Anterior open bites of this type are often not difficult to correct, provided the digit sucking is discontinued.



Fig. 6.25 The above case showed a near-average vertical skeletal pattern, and the dental open bite was related to thumb sucking. It is normally possible to correct anterior open bites of this type, provided the thumb-sucking activity is discontinued. If the open bite is related to tongue posture, the prognosis for permanent correction is more doubtful.

Early management of open bites

Patients who present with anterior open bites may benefit from an early phase of treatment. A number of treatment modalities have been suggested for this early management. The following possibilities can be considered, and are listed in order of ease of application and treatment:

- Finger and thumb appliances, which provide a barrier, can be used to correct minor problems. These appliances normally extend forward from the upper first molars, but are sometimes attached to the lower first molars.
- Palatal expansion in cases with narrow maxillas. This procedure provides space for eruption and retroclination of incisors. It also helps to open the airway and encourage nasal breathing, while providing more room for the tongue.
- Palatal bars and lingual arches can be placed on the molars. These appliances serve to reduce the vertical eruption of the molars.
- Posterior bite plates can be placed on the upper or lower posterior teeth. However, if these only passively rotate the mandible open (especially in high-angle cases), their effect may be minimal, since little pressure seems to be exerted on the dentition.
- High-pull facebows and vertical chin cups, when worn faithfully, can limit the vertical eruption of the upper molars and the upper and lower molars, respectively. However, cooperation is always the limiting factor with such appliances.
- Removal of deciduous canines and sometimes premolars in cases with significant crowding and/or protrusion allows for the eruption and retroclination of incisors.
- Myofunctional therapy may benefit more severe cases. It should be noted that a significant number of open-bite cases show improvement as the airway increases in size during orthodontics. Therefore, only a few patients require this service.
- If adenoids and tonsils are contributing factors to anterior open bites, their removal may aid in bite closure. Referral to an ear, nose and throat specialist is indicated in such cases.

Management of anterior open bite during full orthodontic treatment

Some general considerations for the management of anterior open bite during full-banded orthodontic treatment are included in this section. While non-extraction treatment is generally preferred in orthodontics, some open-bite cases may benefit from extractions, primarily to allow for eruption and retroclination of incisors. Some possibilities are as follows:

- If the upper and lower arches show crowding and/or protrusion, upper and lower bicuspid extractions can be considered.
- If the lower arch does not require extraction for lower incisor retroclination, and the molars are more than 3–4 mm Class II, extraction of upper bicuspid only can be considered (Case IJ, p. 184). This will allow for the retraction and retroclination of upper incisors.
- If the lower arch does not require extraction for incisor retroclination, and the molars are less than 3 mm Class II, extraction of upper bicuspid is a concern. It is most difficult to move upper molars forward 4–7 mm and keep their roots in an upright position. This is required for proper Class II molar occlusion. Upper second molar extraction can be considered in such cases, if good third molars are present. This allows for easy distalization of first molars, without opening of the mandibular plane.
- During bracket placement of open-bite cases, the upper and lower anterior brackets can be placed 0.5 mm more gingival than normal (p. 65). This simple procedure helps to achieve bite closure as treatment proceeds.
- It is not recommended that second molars be banded in the early and middle stages of treatment of open-bite cases, because this can lead to the extrusion of the premolars and first molars, and further bite opening. If second molars need to be banded for improved positioning or for torque control later in treatment, it is beneficial to leave curve of Spee in the posterior aspect of the lower arch and to step the archwire up to the second molars in the upper arch. This will minimize extrusion of first molars and bicuspid.
- Appliances described above such as tongue appliances, palatal bars, lingual arches, posterior bite plates, high-pull facebows, and vertical chin cups can be helpful in these cases. Also, tonsil and adenoid evaluation, as well as myofunctional therapy, can be considered.
- If Class II (Figs 6.26 & 6.27) or Class III elastics are required, they should be attached posteriorly to premolars rather than molars. These 'short' elastics minimize the extrusive effect on the back of the arches.
- The removal of acrylic from the incisor area of the upper retainer is recommended, along with the placement of a small hole in the anterior region as a reminder for the tongue. Positioners can be considered during retention, because of their bite-closing effect (p. 311).

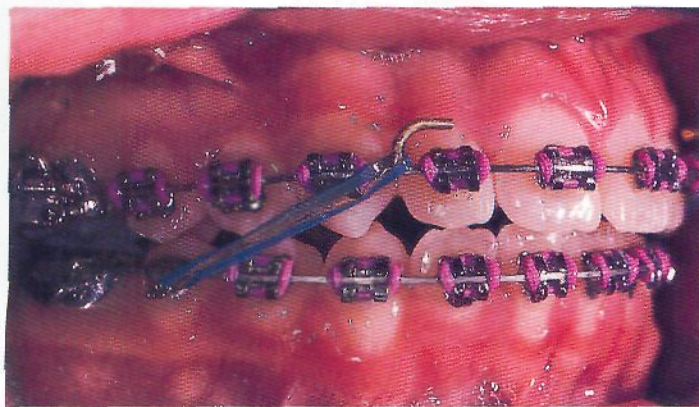


Fig. 6.26 Short Class II elastics can be helpful in managing anterior open-bite Class II cases. Here, Class II elastics are carried to hooks on lower second premolar tubes.



Fig. 6.27 In this Class II anterior open-bite case, second premolars were extracted. Short Class II mechanics were applied to Kobayashi ties on the lower first premolars.

CASE MP

A male patient, aged 12.7 years, with Class II skeletal bases (ANB 6°) and bimaxillary protrusion and proclination on an average angle pattern of MM 27°.

The patient was in the late mixed dentition with all permanent teeth developing. There was some lower anterior crowding and an upper midline shift of 2 mm to the right. It was felt that dental correction could be achieved on a non-extraction basis. However, in order to retract the incisors and achieve facial profile improvement, a decision was made to extract all first premolars and manage the case as a maximum anchorage treatment. An upper palatal bar and a lower lingual arch were placed at the start of treatment. Headgear support was used at night in order to achieve treatment goals.

Tooth leveling and aligning procedures were commenced with .016 HANT wires, followed by rectangular HANT wires. Here, the case is seen with rectangular steel wires and passive tiebacks in place, prior to commencement of correction of overjet and overbite, followed by space closure.



Fig. 6.28



Fig. 6.31

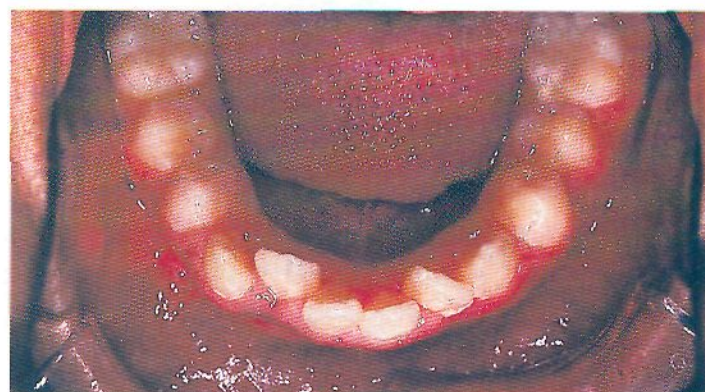


Fig. 6.34

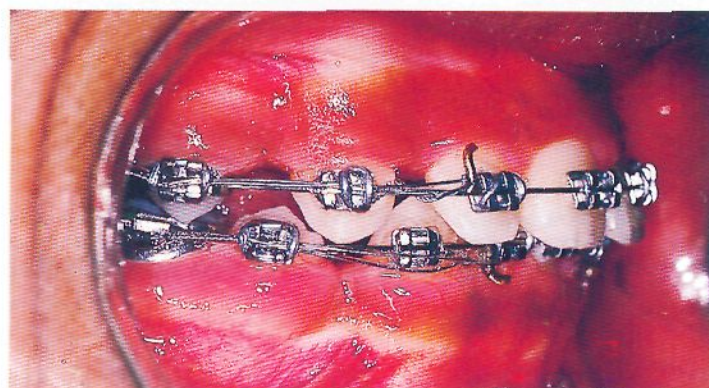


Fig. 6.37



Fig. 6.29

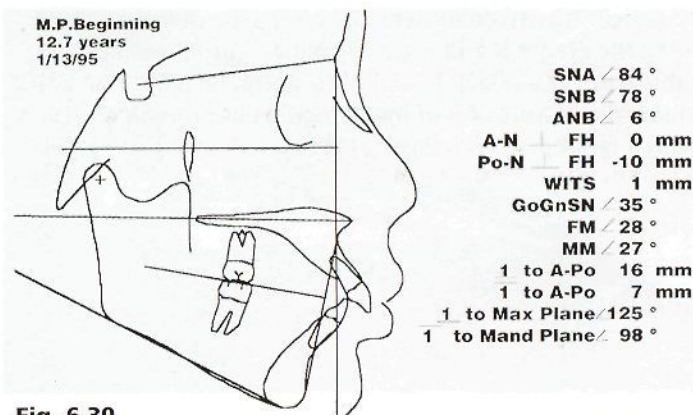


Fig. 6.30



Fig. 6.32



Fig. 6.33

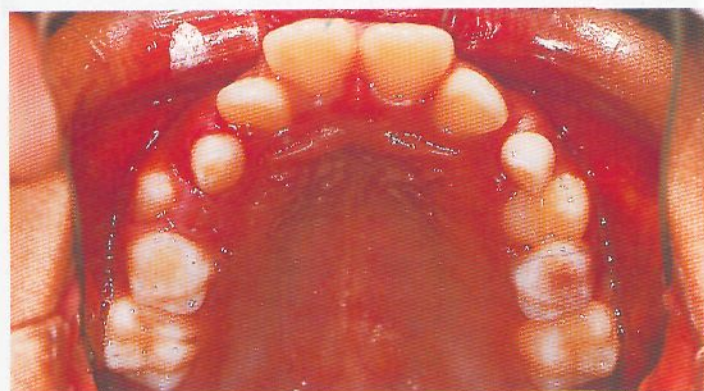


Fig. 6.35



Fig. 6.36

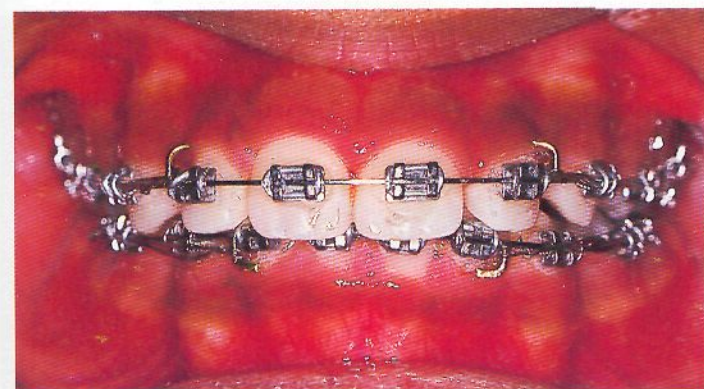


Fig. 6.38

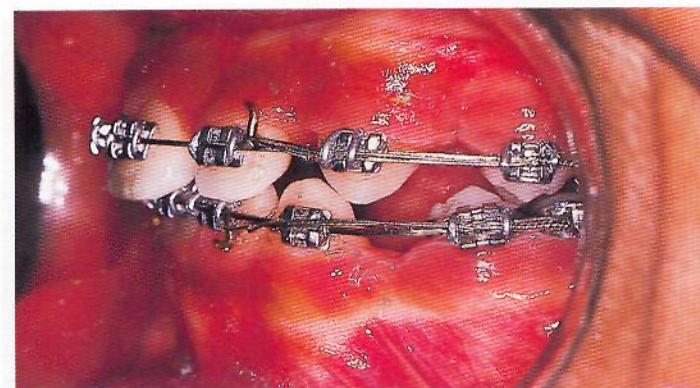


Fig. 6.39

The patient was asked to wear a 'J' hook type of headgear during the evenings and nights, together with Class II elastics. In this type of case, a 'J' hook headgear can be helpful in both retraction and intrusion of upper incisors in order to achieve optimal facial profile change.

During space closure, the lower lingual arch was discontinued but the upper palatal bar remained in place to support upper anchorage.

After the rectangular wires had been in place for 2 months, bite-opening curves were introduced (p. 137).

Lower second molars (p. 136) were banded to assist in correction of the lower curve of Spee. Here, the case is seen after 16 months of treatment. The lower first molar bands were repositioned.

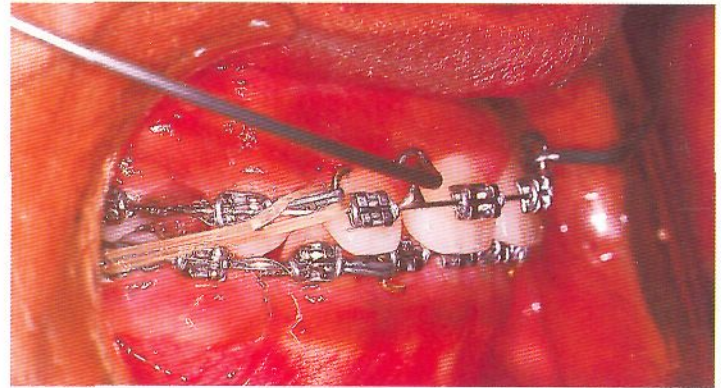


Fig. 6.40

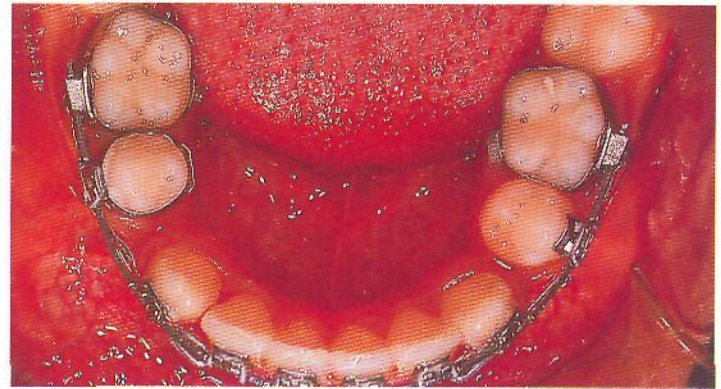


Fig. 6.43

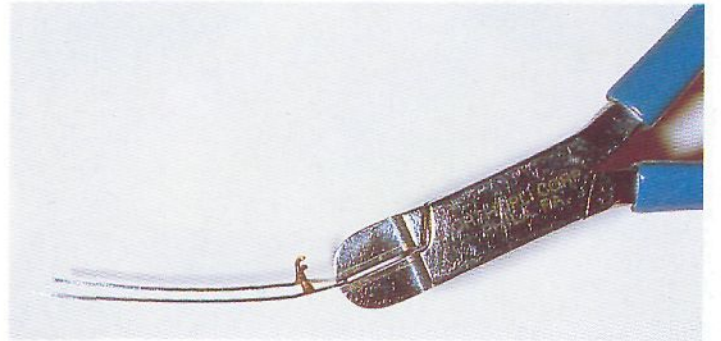


Fig. 6.46

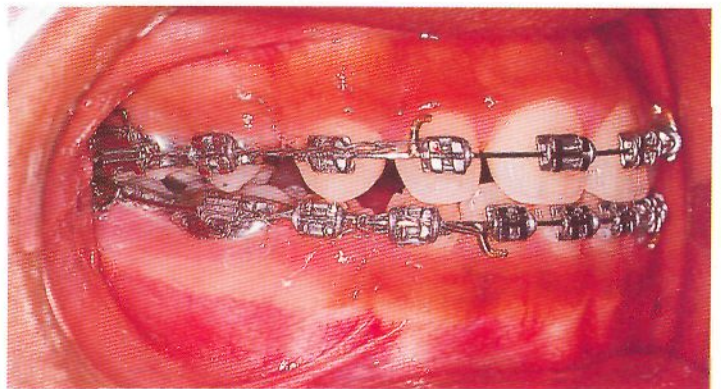


Fig. 6.49

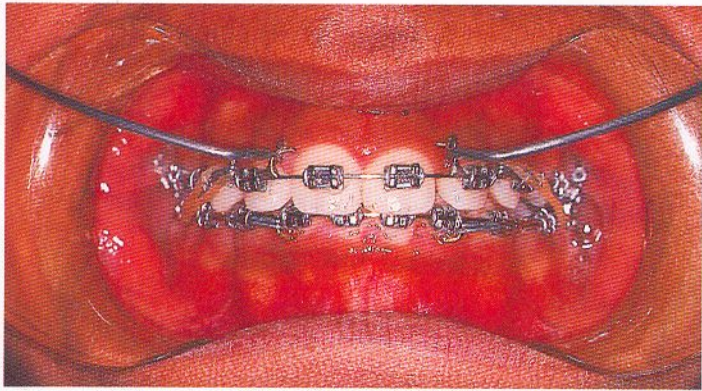


Fig. 6.41

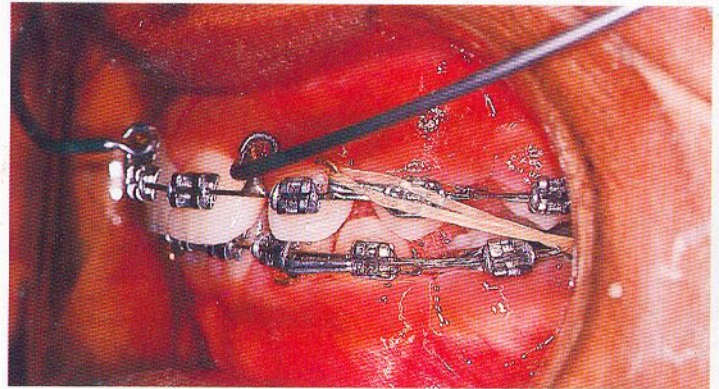


Fig. 6.42

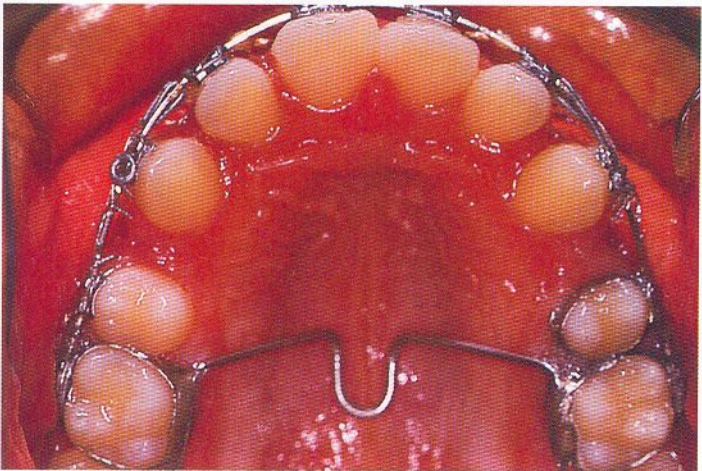


Fig. 6.44

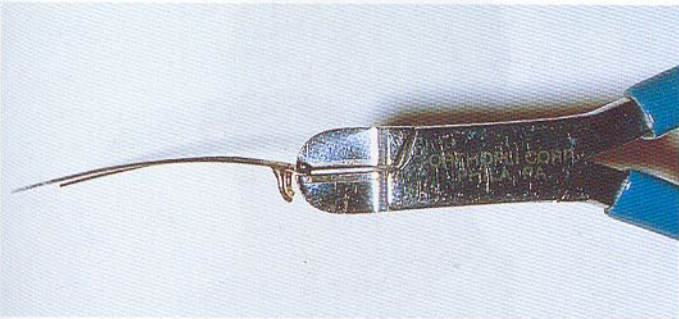


Fig. 6.47

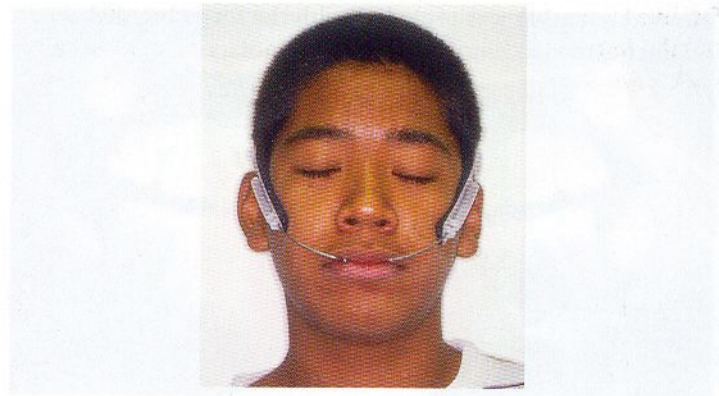


Fig. 6.45

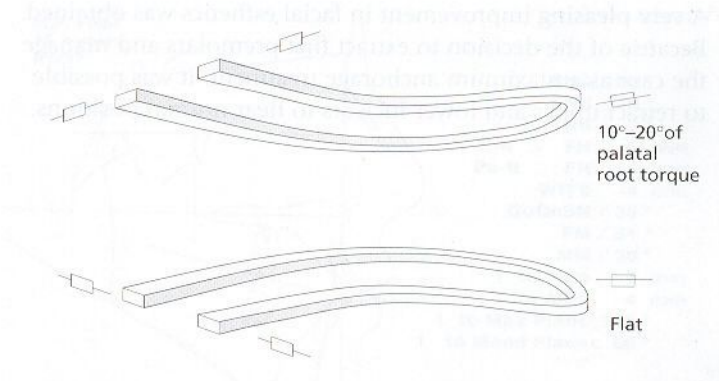


Fig. 6.48

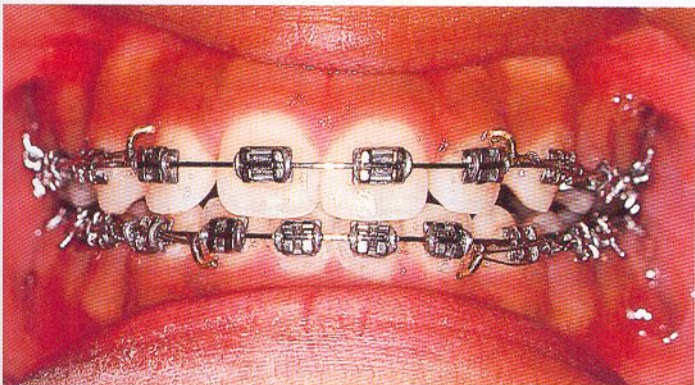


Fig. 6.50

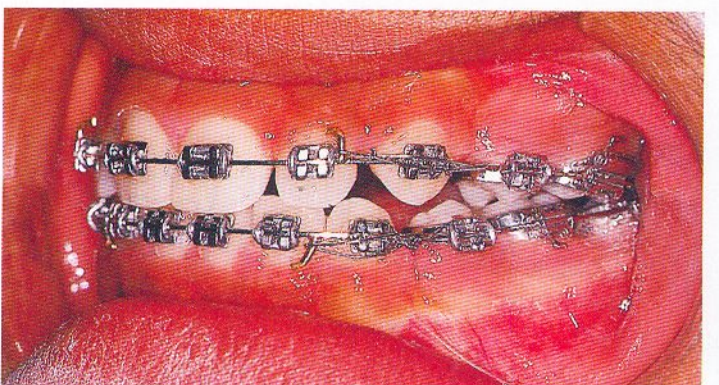


Fig. 6.51

Normal finishing procedures were followed, and appliances were removed after 23 months of active treatment.

Normal retention was provided, with the lower bonded retainer extended onto the second premolars.

A very pleasing improvement in facial esthetics was obtained. Because of the decision to extract first premolars and manage the case as a maximum anchorage treatment, it was possible to retract upper and lower incisors to near normal positions.

Considerable downward and forward mandibular growth took place during treatment, which assisted the treatment mechanics.



Fig. 6.52

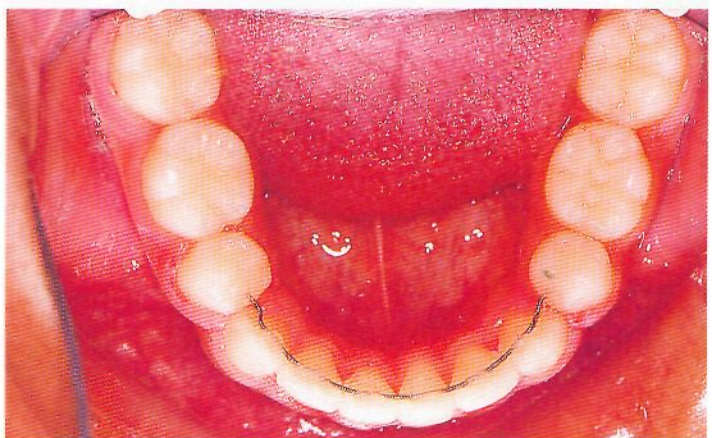
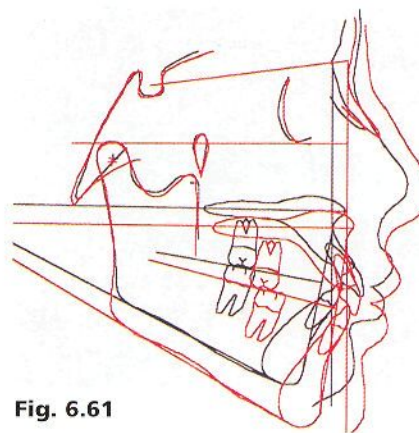


Fig. 6.55



Fig. 6.58



SN at S

**M.P.Begin
M.P.Final**

Fig. 6.61



Fig. 6.53



Fig. 6.54

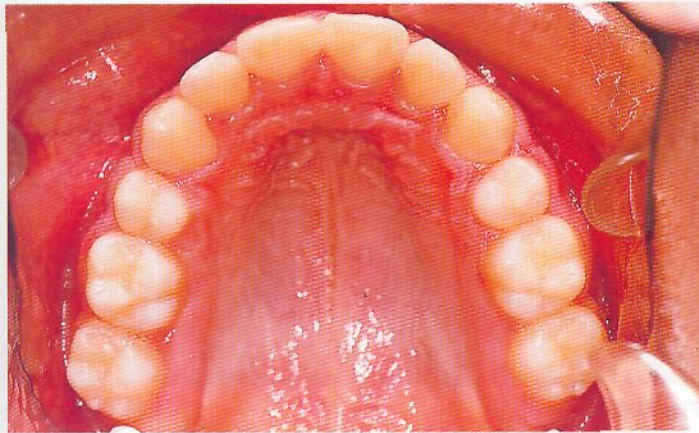


Fig. 6.56

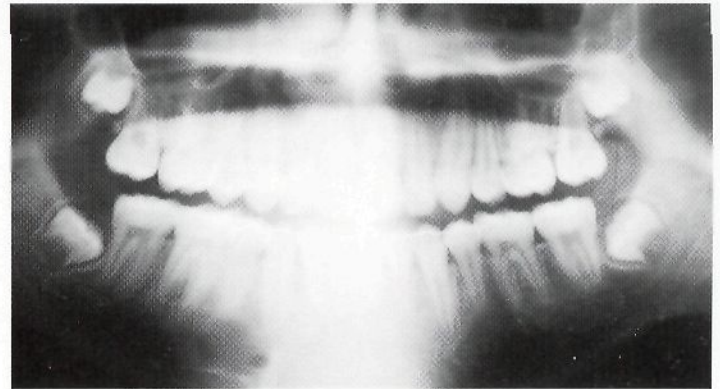


Fig. 6.57



Fig. 6.59

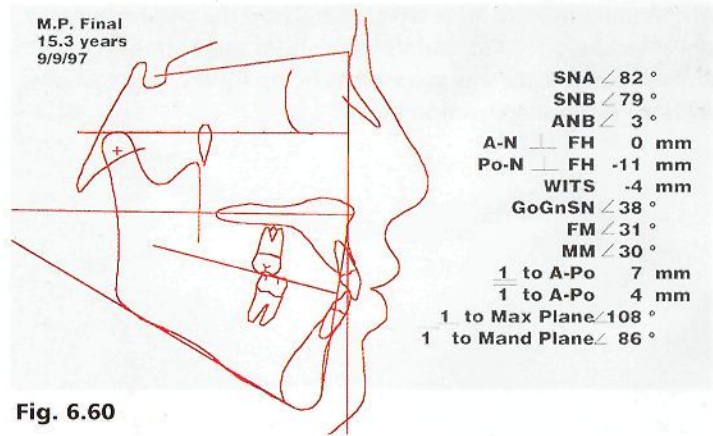


Fig. 6.60

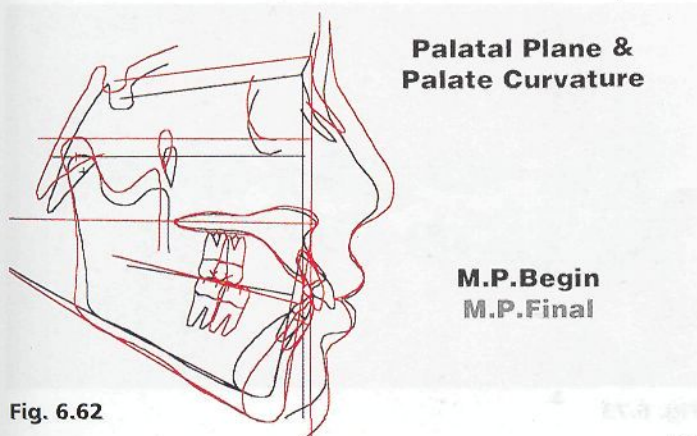


Fig. 6.62

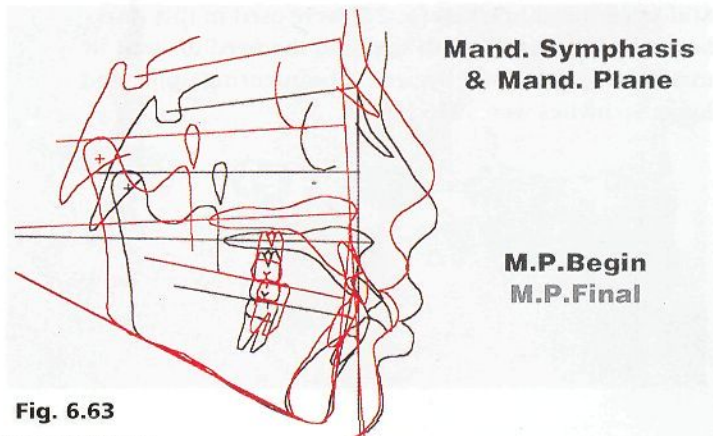


Fig. 6.63

CASE CW

A female patient, aged 10.3 years, with Class I dental bases on an average vertical pattern, but with a deep overbite and lower incisors at -1° APo. Facial profile was slightly Class II with a hint of mandibular retrognathism.

Intraorally, the molars were half a unit Class II bilaterally. The lower midline was 1 mm to the right.

All permanent teeth were developing, and the two remaining upper primary second molars were about to be shed. The patient's arch form was assessed as being square. The case was treated on a non-extraction basis.

Mid-sized metal brackets (p. 28) were used in this case because of the small tooth size, and the need to assist in maintaining good oral hygiene. Commencing upper and lower archwires were .016 HANT.



Fig. 6.64



Fig. 6.67

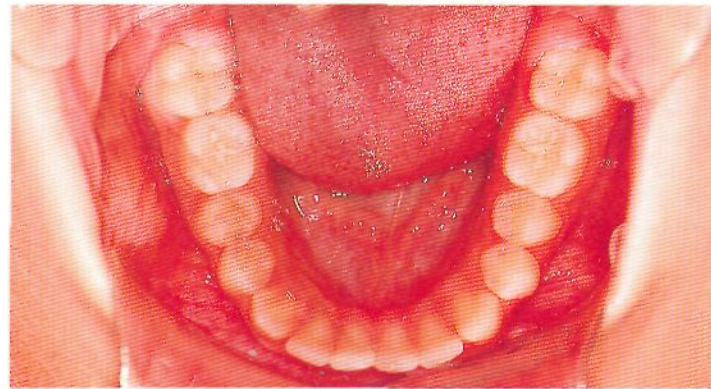


Fig. 6.70

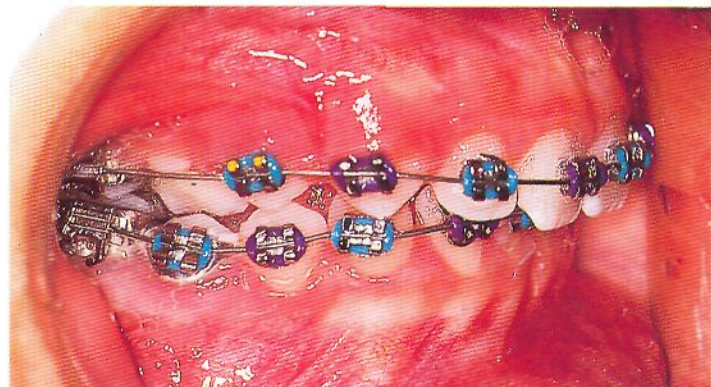


Fig. 6.73



Fig. 6.65

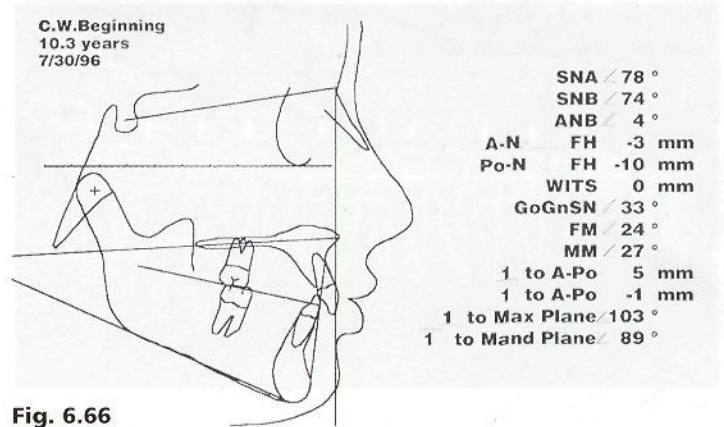


Fig. 6.66



Fig. 6.68

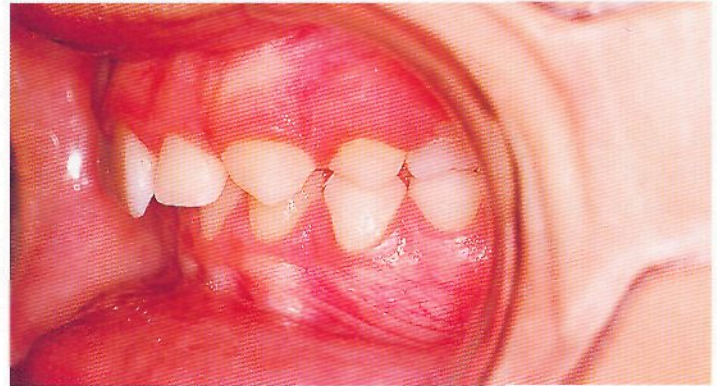


Fig. 6.69

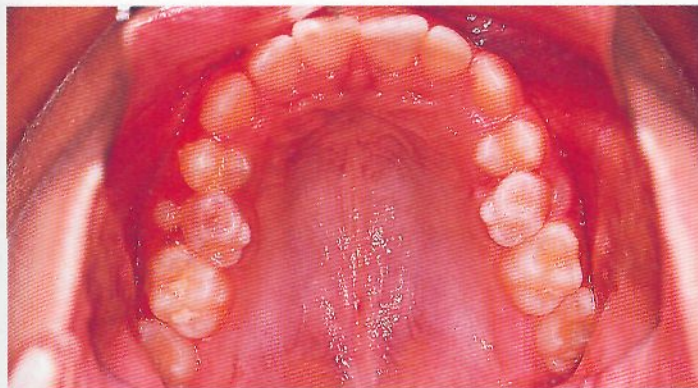


Fig. 6.71

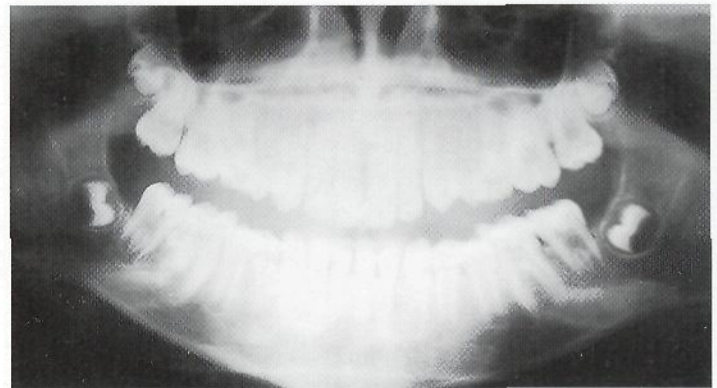


Fig. 6.72

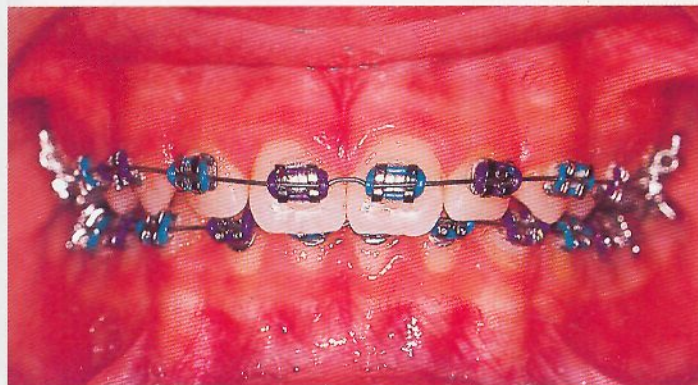


Fig. 6.74

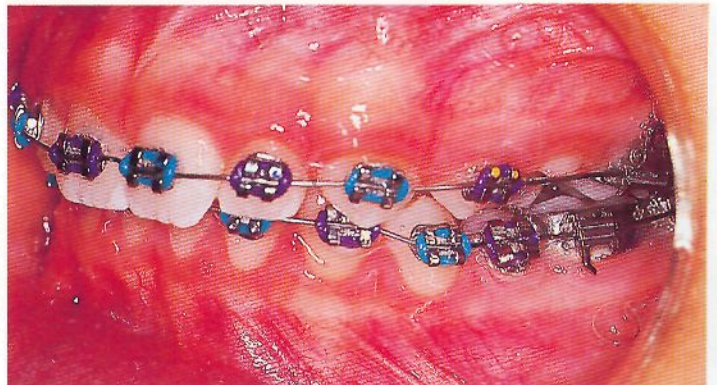


Fig. 6.75

Lower second molars were banded at this stage of the treatment, to assist in overbite control.

The initial .016 HANT wires were followed by rectangular .017/.025 HANT wires. Here, the case is seen after 3 months of treatment, with passive coil springs in place to hold space for the erupting upper second premolars.

After 6 months of treatment, it was possible to place upper and lower rectangular steel wires with a square arch form. Once these had been in place for 3 months, additional anterior torque was added, together with slight bite-opening curves.

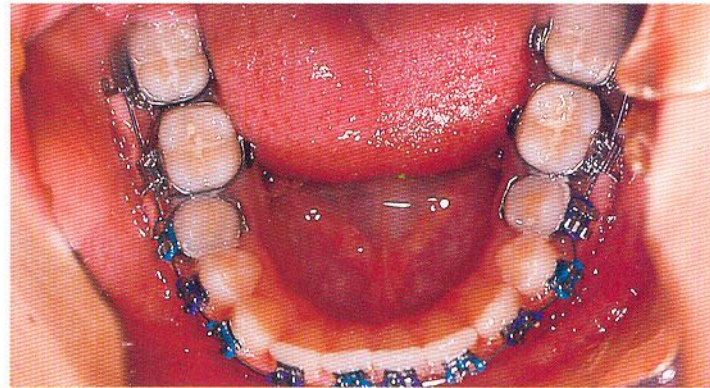


Fig. 6.76

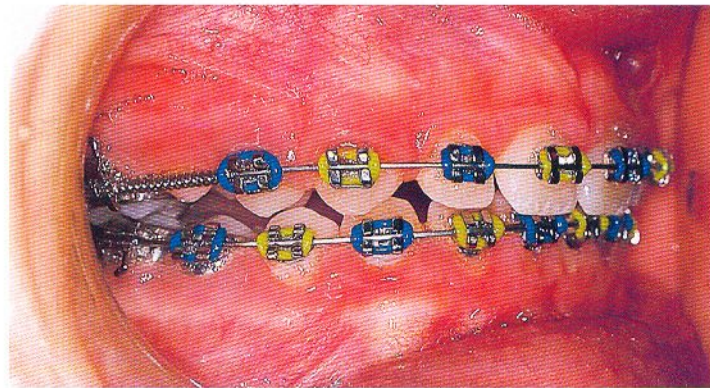


Fig. 6.79

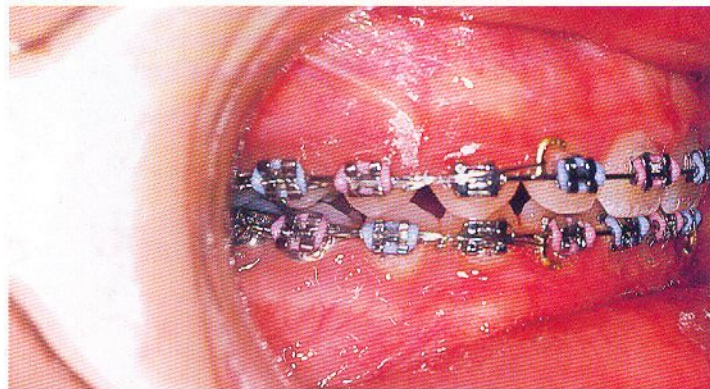


Fig. 6.82

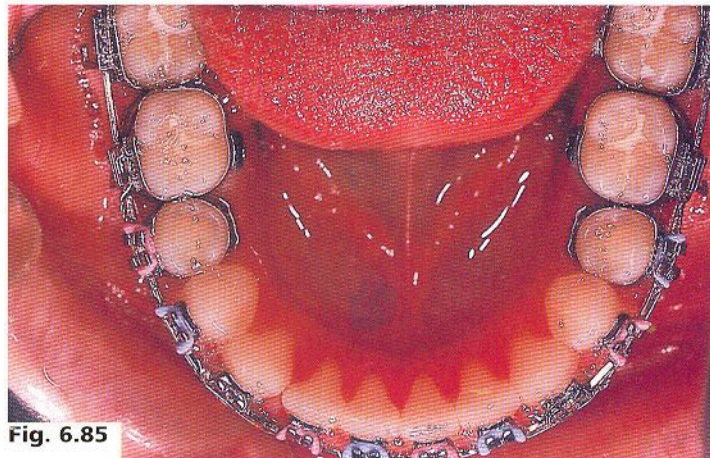


Fig. 6.85

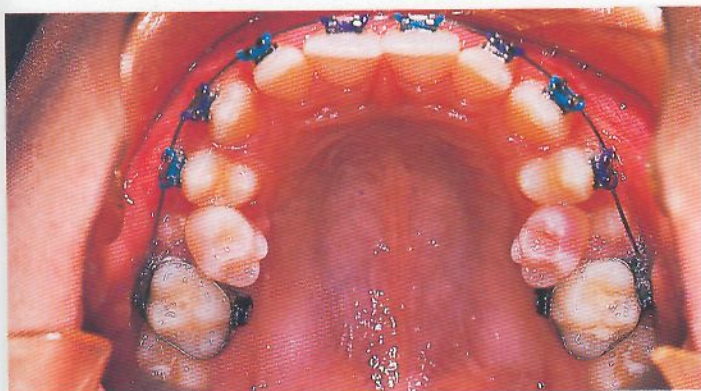


Fig. 6.77

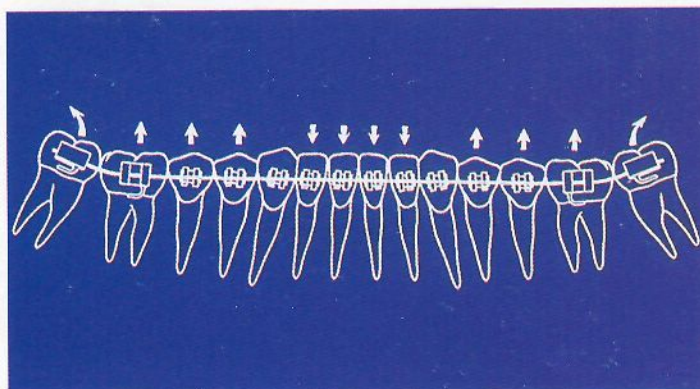


Fig. 6.78

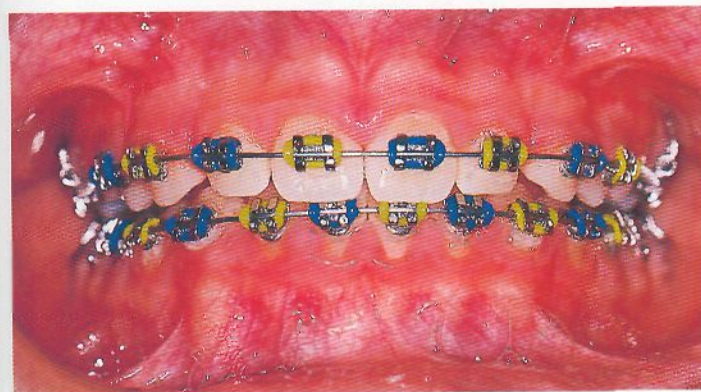


Fig. 6.80

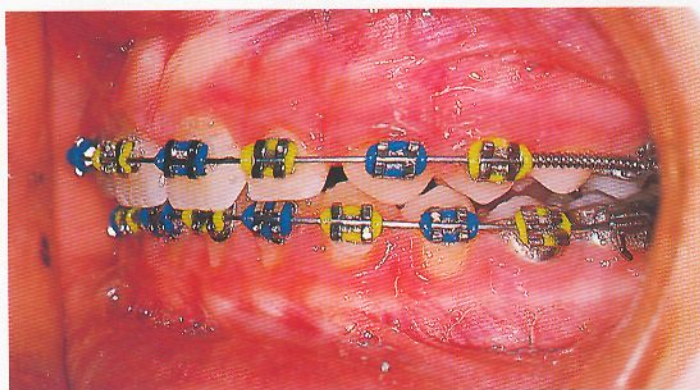


Fig. 6.81

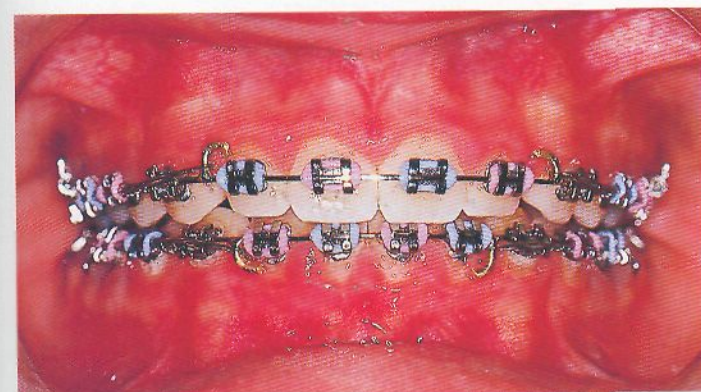


Fig. 6.83

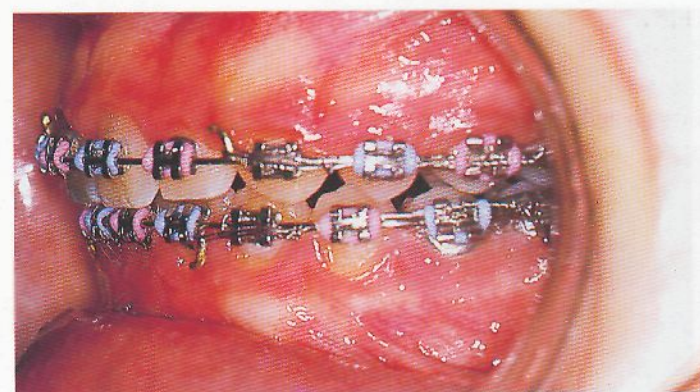


Fig. 6.84

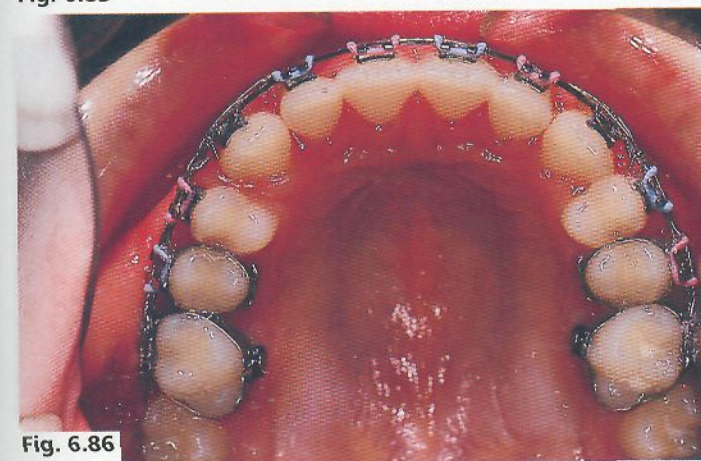


Fig. 6.86

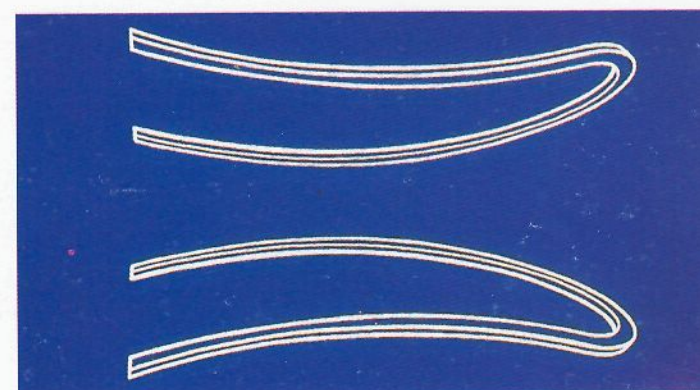


Fig. 6.87

The case after 8 months. The patient was asked to wear light Class II elastics (100 gm). At this stage, it is necessary to await upper incisor torque improvement before the buccal occlusion and incisor relationship can be finally corrected.

At 18 months into treatment, upper and lower steel rectangular wires are continuing and upper incisor torque changes have taken place, allowing correction of the buccal occlusion and anterior overbite. Lower passive tiebacks and upper active tiebacks are in place.

Normal settling procedures were followed. Here, the case is seen immediately prior to appliance removal.

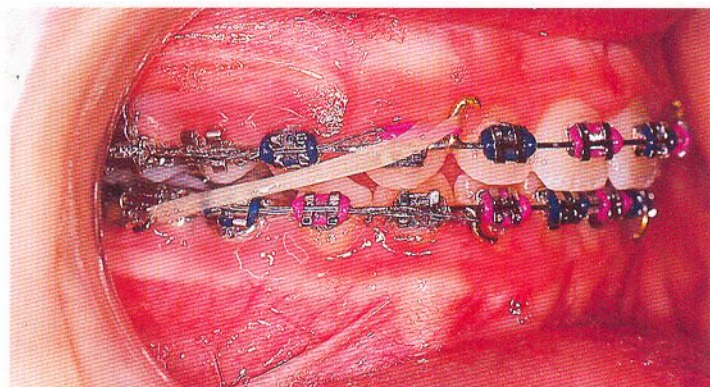


Fig. 6.88

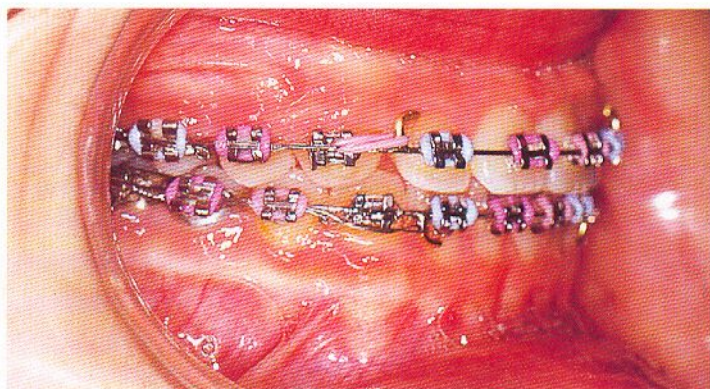


Fig. 6.91

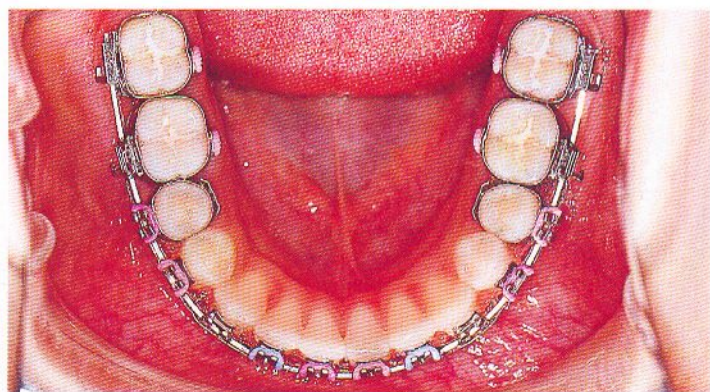


Fig. 6.94



Fig. 6.97

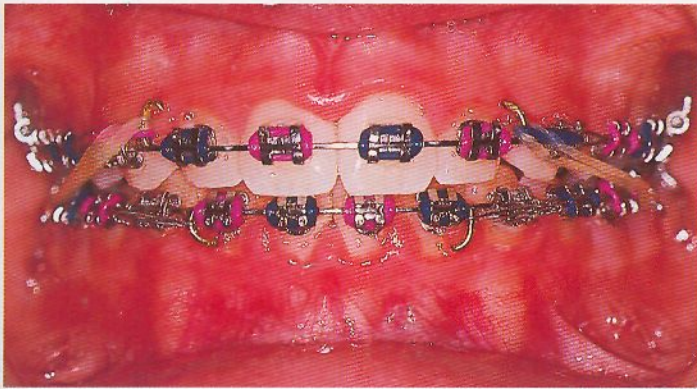


Fig. 6.89

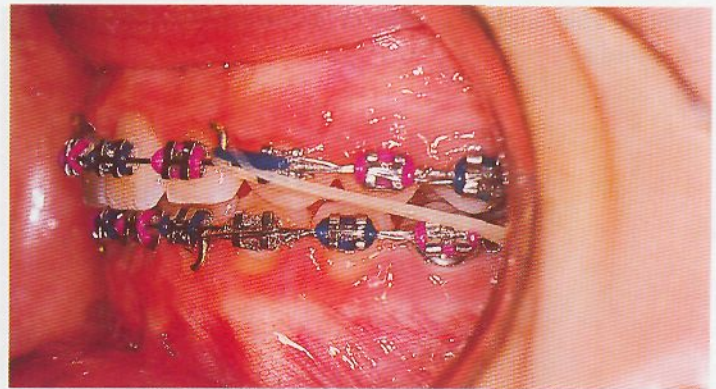


Fig. 6.90

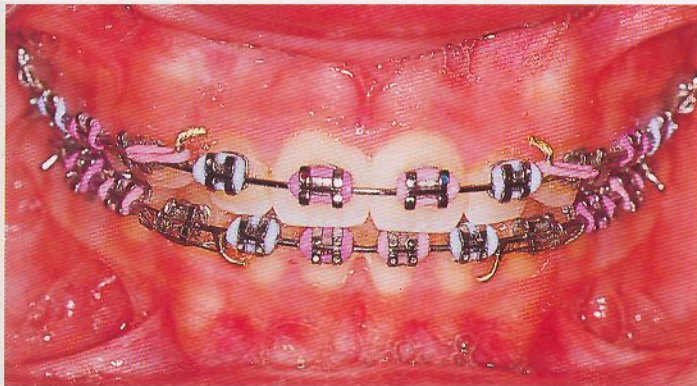


Fig. 6.92

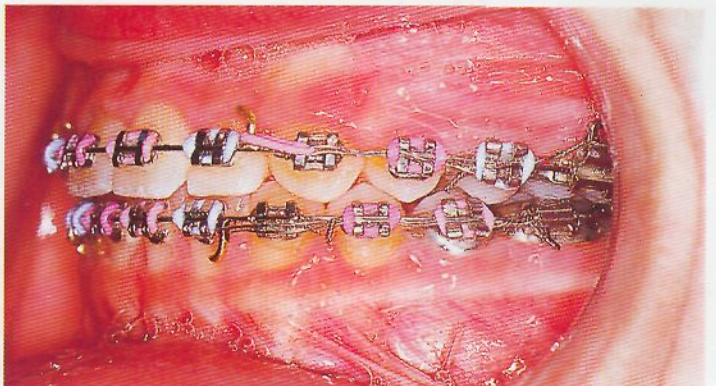


Fig. 6.93



Fig. 6.95

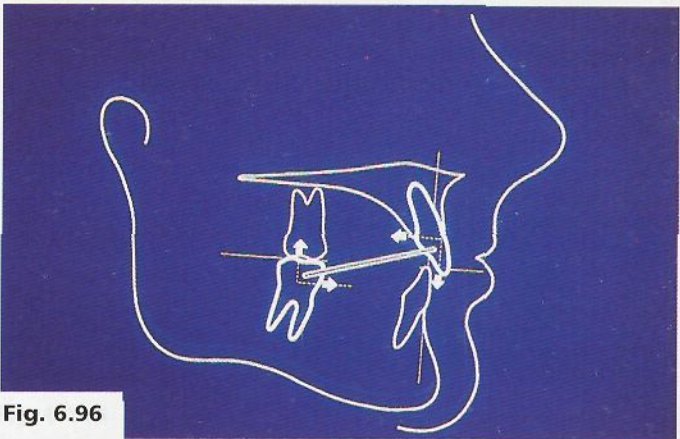


Fig. 6.96



Fig. 6.98



Fig. 6.99

The case after appliance removal. Active treatment time was 23 months.

Normal retention procedures were followed. The radiographs indicate that there is adequate space for the developing third molars.

A pleasing improvement in facial profile was achieved in this case. The position of the incisors in the facial profile was close to ideal in terms of vertical positioning, A/P position, and torque.

Some favorable growth occurred during treatment, which assisted in achieving good overbite control and reaching the treatment objectives.



Fig. 6.100

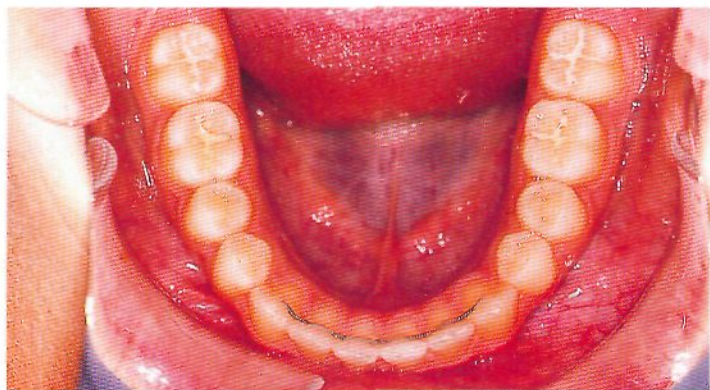
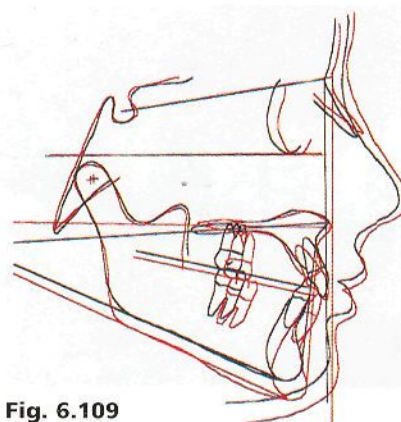


Fig. 6.103



Fig. 6.106



SN at S

**C.W.Begin
C.W.Final**

Fig. 6.109

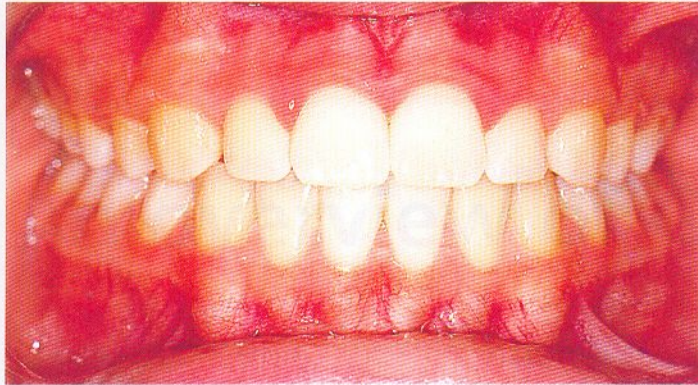


Fig. 6.101



Fig. 6.102

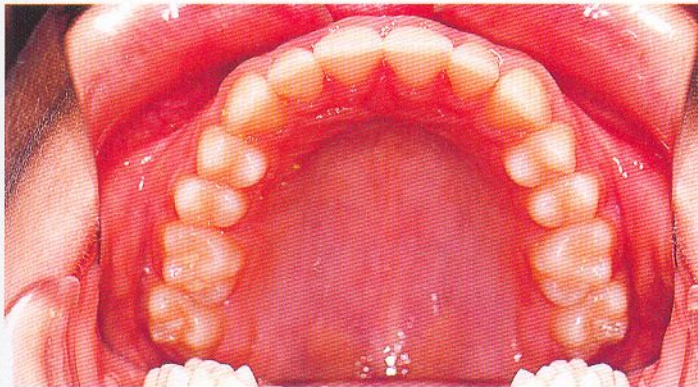


Fig. 6.104

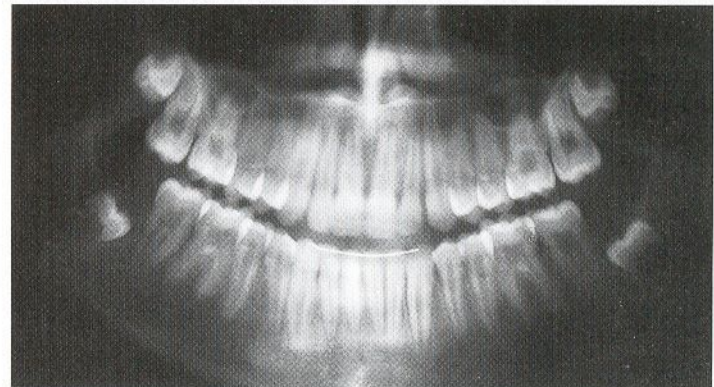


Fig. 6.105



Fig. 6.107

C.W.FINAL
12..4 years
8/27/98

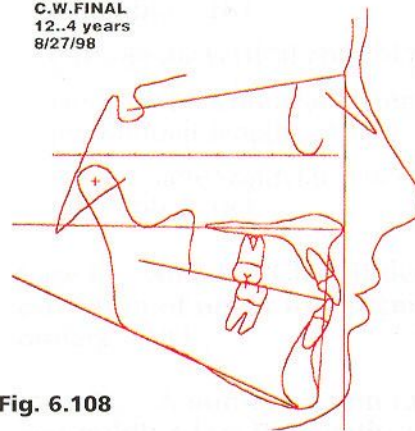


Fig. 6.108

SNA	75°
SNB	74°
ANB	1°
A-N FH	-5 mm
Po-N FH	-9 mm
WITS	-2 mm
GoGnSN	34°
FM	25°
MM	24°
1 to A-Po	5 mm
1 to A-Po	2 mm
1 to Max Plane	119°
1 to Mand Plane	91°

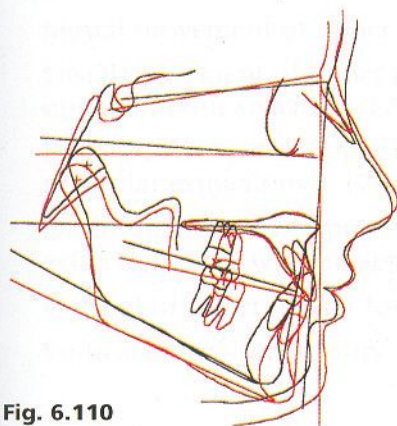


Fig. 6.110

Palatal Plane &
Palate Curvature

C.W.Begin
C.W.Final

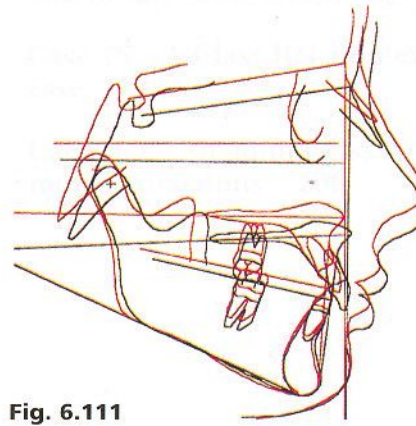


Fig. 6.111

Mand. Symphysis
& Mand. Plane

C.W.Begin
C.W.Final

An overview of Class II treatment

Introduction 162

The shift in emphasis from molars to incisors 162

The concept of 'ideal' incisor position in treatment planning 162

Planned incisor position 162

The limitations of orthodontics 163

The surgical/non-surgical decision in Class II treatment 163

Identifying severe Class II cases 164

The four-stage treatment planning process 166

Setting a PIP for upper incisors 166

The lower incisors 166

The remaining lower teeth 167

The remaining upper teeth 167

PIP components in Class II treatment 168

A/P component 168

Torque component 169

Vertical component 169

Upper incisor movement in Class II cases 170

Mesial movement of upper incisors 170

Distal movement of upper incisors in cases with upper anterior spacing 172

Distal movement of upper incisors after upper premolar extractions 173

Distal movement of upper incisors in non-extraction cases without spacing 173

Control of upper incisor torque 174

Vertical control of incisors 177

Positioning of lower incisors in Class II cases 178

Control of the A/P position of lower incisors 178

Movement of lower incisors in the mandibular bone 179

Favorable change in mandibular length or position 180

Mandibular growth 180

Augmentation of mandibular position with functional appliances? 181

Favorable condylar repositioning of the mandible 181

Orthopedic vertical control of the maxilla? 181

Unfavorable condylar changes, causing reduced mandibular length 182

Unfavorable condylar repositioning of the mandible 183

Case LJ An adult Class II deep bite case with extraction of upper first premolars and all third molars 184

Case TC A non-extraction case, Class I skeletally and mildly Class II dentally 192

Case TS A Class II/1 non-extraction twin block case 198

Case DO An adult Class II/2 which required molar extractions 206

INTRODUCTION

The subject of Class II treatment is extensive, and an in-depth discussion is beyond the scope of this text. The purpose of this chapter, therefore, is to present an overview of this subject, emphasizing the key aspects of diagnosis, treatment planning, and treatment mechanics.

The shift in emphasis from molars to incisors

When Angle introduced his classification in the late 1920s, orthodontics focused primarily on the molar relationship as Class I, Class II, or Class III. Non-extraction treatment and expansion was generally the treatment of choice. In the 1940s Tweed¹ moved the emphasis to the lower incisors, with extraction treatment becoming more prevalent. This was clearly a reaction against the shortcomings of excessive non-extraction treatment. However, it should also be noted that the emphasis on the lower incisors, with minimized emphasis on the upper incisors, was due to the fact that surgical correction was not available at the time, nor was improved facial appearance with functional appliances. The orthodontist was relegated to deciding a stable lower incisor position and then moving the upper incisors into contact with the lowers.

It should also be emphasized that in many Class I treatments the malocclusion may be corrected by tooth alignment only, accepting the position of the upper and lower incisors in the face. This is so-called 'tooth alignment' orthodontics, and it can be straightforward using the preadjusted bracket system.

However, the majority of orthodontic cases require changes in incisor position. In addition to 'tooth alignment', most cases require more challenging 'denture-positioning' procedures. For example, all malocclusions with a Class II or Class III incisor relationship will require treatment planning and then treatment mechanics to achieve not only pleasing tooth alignment, but also denture positioning in the facial complex for optimal facial esthetics.

The concept of 'ideal' incisor position in treatment planning

With the advent of improved orthodontic and surgical techniques, emphasis has shifted more toward the upper incisors as a starting point. Today, it is possible to base treatment planning on the position of the upper incisors, instead of using the molars or the lower incisors as a starting point. At the start of treatment planning, it is possible to envision an 'ideal' position for the upper incisors. For many cases, treatment mechanics can then be planned to position the incisors ideally, and subsequently to fit all the other teeth around this ideal position. In other cases, the 'ideal' incisor position will not be a realistic goal, and a less than ideal, but nonetheless acceptable, position for the incisors needs to be used as a basis for treatment planning.

Planned incisor position

Planned incisor position (PIP) may be defined as:

The intended end-of-treatment position for upper incisors.

In some cases, the perceived ideal upper incisor position will be a realistic treatment goal, and can become the PIP for that case. In other cases, the ideal incisor position may not be a realistic goal, for various reasons. In such cases, the perceived ideal incisor position has to be adjusted to reflect the limiting features of the case, such as lack of cooperation or growth potential. Then a PIP has to be accepted which is not ideal, but which is acceptable for the case.

The limitations of orthodontics

In some cases, it will become evident during treatment planning that there are major limiting features, such as skeletal disproportion, which cannot be resolved by orthodontics alone. It is important to identify such cases, and consider a surgical/orthodontic solution in order to achieve an acceptable PIP. If there are major limiting features, it is normally better not to commence treatment on the basis of orthodontics alone. In such cases, there is a probability of adverse facial change, due to an unacceptable end of treatment incisor position, as a consequence of attempting to achieve a 'better bite' only.



Dr G. William Arnett

The surgical/non-surgical decision in Class II treatment

The soft tissue cephalometric analysis, or STCA, has been advocated by Arnett et al^{2,3,4} as an aid for orthodontists and surgeons in treatment planning. It recommends analysis using a true vertical line (TVL) through subnasale, with natural head posture. It may also be used to quantify favorable or unfavorable change in the profile after overjet reduction, and hence has an important potential role in post-treatment analysis and in research. The STCA includes normal values for many aspects of facial profile and harmony, but in the following theoretical situations only seven of these will be considered (Fig. 7.1). For reasons of clarity, all other STCA values will be disregarded in this discussion, and it will be assumed that the upper- and mid- thirds of the facial profile are close to ideal, and that the upper incisors are well positioned.

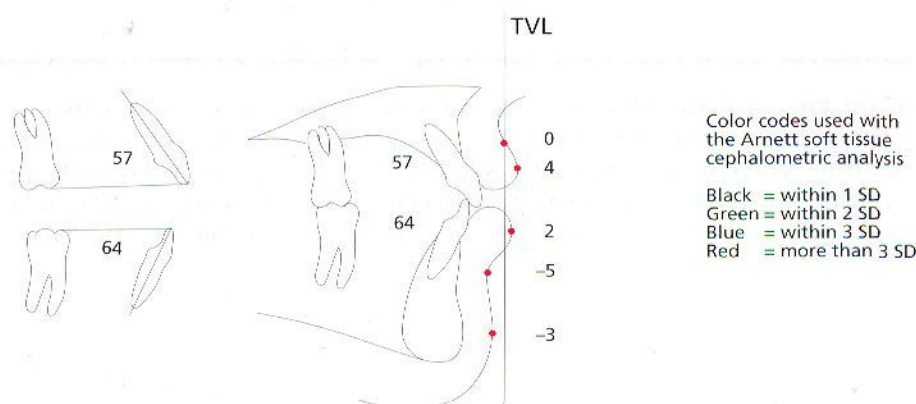


Fig. 7.1 Only seven measurements from the STCA are included here. The upper incisor torque is measured relative to the maxillary occlusal plane and the lower incisor torque is measured relative to the mandibular occlusal plane. In this diagram, the following are projected to true vertical line (TVL): Soft tissue 'A' point, upper lip anterior, lower lip anterior, soft tissue 'B' point, and soft tissue pogonion. Black numbers are within 1 SD of normal.

Identifying severe Class II cases

Orthodontics can be relied upon to achieve a good outcome for most patients with Class I or mild Class II skeletal bases. However, it is important to recognize those Class II cases which have a major skeletal disproportion at the time of assessment. For such individuals, it will be necessary to consider a surgical/orthodontic solution (Fig. 7.2). Treatment on the basis of orthodontics alone should be discarded as a possibility, unless there is a real prospect, in a growing individual, of achieving favorable skeletal change with functional appliances.

The theoretical Class II/1 treatment situations, A, B and C, on the opposite page show some of the potential difficulties.

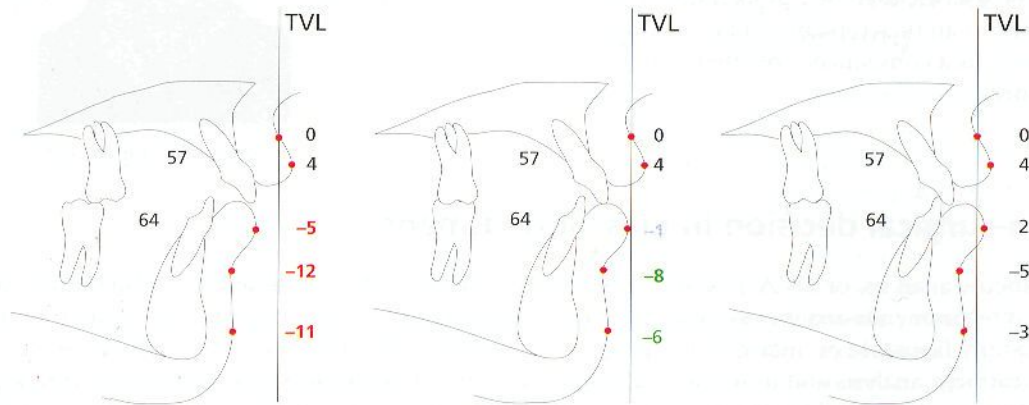


Fig. 7.2 In the above diagrams, the different colors of the Arnett analysis help to highlight the areas and quantity of facial disproportion. The right example is normal. The center example is a moderate Class II/1 malocclusion which may be considered for treatment by orthodontics alone. In the example on the left, it is clear that the severity of the problem may require a combined orthodontic and surgical assessment, and that treatment on the basis of orthodontic treatment alone may need to be discarded as a possibility, unless major skeletal change can be achieved, for a growing individual, with functional appliances (Case TS, pp 198–205).

Situation A – orthodontic masking of a mild Class II. If the underlying skeletal Class II discrepancy is mild, it may be decided to follow a treatment plan based on orthodontics alone. The orthodontist will provide correction by ‘masking’ the underlying Class II discrepancy with dental compensation. This will involve slight retroclination of upper incisors and/or proclination of lower incisors. Good patient cooperation with Class II elastics and/or a headgear will normally be needed in this type of treatment. Treatment should lead to a good dental and an acceptable facial outcome (Fig. 7.3).

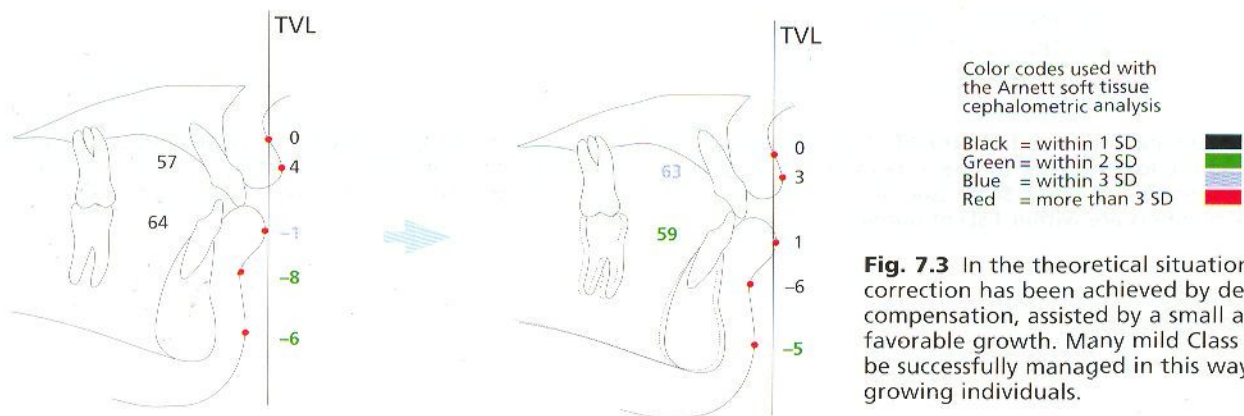


Fig. 7.3 In the theoretical situation A, good correction has been achieved by dental compensation, assisted by a small amount of favorable growth. Many mild Class II cases can be successfully managed in this way, in growing individuals.

Situation B – attempted orthodontic masking of a more severe Class II skeletal problem. If the underlying skeletal Class II discrepancy is moderate to severe, a treatment plan based on orthodontics alone carries risks. If the orthodontist attempts correction of the bite by 'masking' the Class II discrepancy with dental compensation, there is a probability of over-retraction of the upper incisors and a very unfavorable change in facial profile (Fig. 7.4). This also leaves the upper and lower incisors in a position which is unsuitable for successful orthognathic surgery, if this is to be provided later. Further orthodontic treatment will be required to decompensate the anterior teeth, so that maximum benefit can be obtained from surgery.

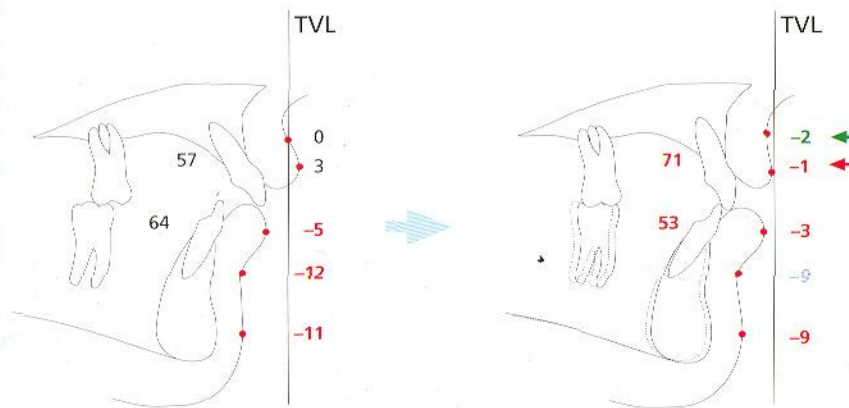


Fig. 7.4 In the theoretical situation B, an attempt has been made to correct a severe Class II problem by orthodontics alone, and there has been unfavorable change in facial profile. This is clearly seen in the increased number of red Arnett measurements in the right diagram. There has been flattening of the upper lip, with reduced convexity, to give the 'orthodontic look' which has been much criticized in the past. The STCA clearly shows this.

Situation C – combined orthodontic and surgical correction of a severe Class II/1 malocclusion. Patients are understandably anxious to avoid surgery, but for many severe cases, in non-growing individuals, it offers the best possible outcome in dental and facial terms (Fig. 7.5). If mandibular advancement surgery is deemed necessary, the surgeon may wish to delay this until age 16 or later, to allow maturation of the temporomandibular joints, so they are able to support the position of the corrected mandible.

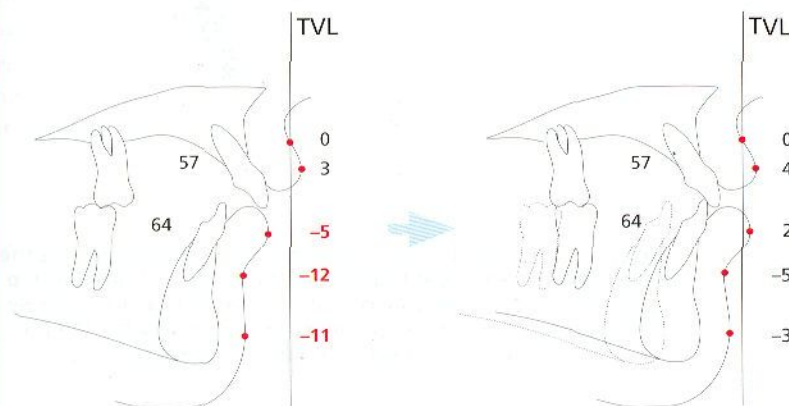


Fig. 7.5 The theoretical situation C is the same at the start as situation B. However, the severe Class II problem has been corrected by combined surgery and orthodontics. The favorable change in facial profile is clearly seen in the black Arnett measurements in the right diagram. Although patients are anxious to avoid surgery, it may offer the best possible outcome in dental and facial terms for severe cases, and it is appropriate to inform the patient of this.

THE FOUR-STAGE TREATMENT PLANNING PROCESS

During treatment planning, the thinking goes through four stages:

Stage 1 – setting a PIP for the upper incisors

What is the ideal position for the upper incisors in the face in terms of A/P position, torque, and vertical positioning? Can ideal upper incisor position be achieved? If not, can an acceptable incisor position be achieved by orthodontics alone, or is it necessary to consider maxillary surgery? In this way, a PIP is determined for the case.

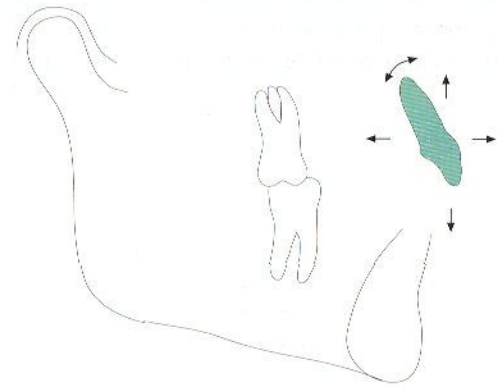


Fig. 7.6 At the start of treatment planning, it is necessary to determine a 'planned incisor position', or PIP, for the upper incisors. In some cases, the perceived ideal upper incisor position is a realistic treatment goal, and can be used as the PIP. In other cases, a PIP can be accepted which is not ideal, but which is acceptable for the case.

Stage 2 – the lower incisors

Is it possible to position the lower incisors in good relationship to the PIP for the upper incisors? Can the required lower incisor position be achieved by orthodontics alone? If not, it will be necessary to modify the PIP for the upper incisors (which may not be feasible), accept a treatment goal with a less than ideal incisor relationship, or consider surgery to the mandible.

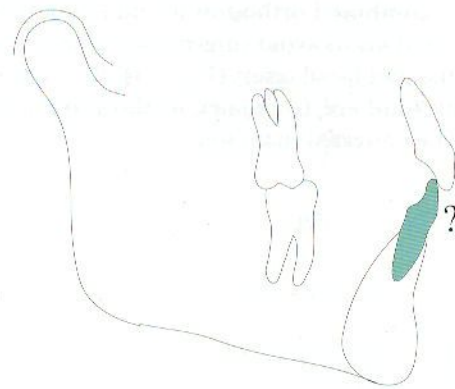


Fig. 7.7 The second stage of treatment planning concerns the lower incisors, and how to position them in good relationship to the PIP for the upper incisors. If this cannot be achieved by orthodontics alone, it will be necessary to modify the PIP for the upper incisors, or consider mandibular surgery.

Stage 3 – the remaining lower teeth

How can the rest of the lower teeth be positioned to fit the planned lower incisor position? How is any lower spacing to be managed? Does this need to be an extraction case to deal with lower crowding? The dental VTO (p. 227) can be used at this stage of the planning process, to reach a correct extraction decision. The primary factors are crowding, curve of Spee, and midlines. The secondary factors are expansion, distalization of molars, inter-proximal enamel reduction, and 'E' space. The orthodontist's view about the possible amount of expansion and the acceptable degree of lower incisor proclination will be variables.

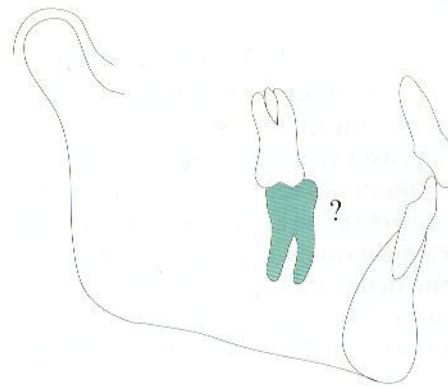


Fig. 7.8 The third treatment planning stage concerns lower arch crowding or spacing, and the extraction decision. How can the rest of the lower teeth be positioned to fit the planned lower incisor position, and will extractions be needed?

Stage 4 – the remaining upper teeth

How can the rest of the upper teeth be positioned to fit the PIP for the upper incisors? How will upper crowding or spacing be dealt with, and what treatment mechanics will be needed to correctly position the upper molars and premolars? The dental VTO will confirm the required tooth movements for upper canines and molars.

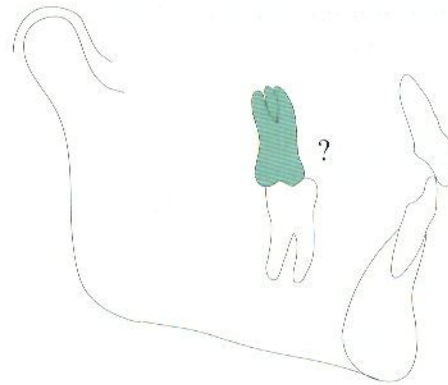


Fig. 7.9 Finally, in the treatment planning process, it is necessary to decide how to position the rest of the upper teeth correctly. How will crowding or spacing be dealt with, and what treatment mechanics will be needed?

PIP COMPONENTS IN CLASS II TREATMENT

For each case, it is necessary to set a PIP as a treatment goal which will result in the upper incisors having correct A/P and vertical positioning, with appropriate torque. Each orthodontist will have a view about what the exact goals for the upper incisor position should be for a particular case, although there is likely to be broad consensus about the approximate treatment needs. It is beyond the scope of this text to discuss and define those goals in detail. However, general comments will be made, based on conventional cephalometric values and also on the Arnett analysis.²⁻⁴

The antero-posterior component of PIP in Class II treatment

Traditionally in orthodontics the upper incisor A/P position has been related to the APo line with a conventional cephalometric value of +6 mm (Fig. 7.10). The Arnett analysis relates upper incisor position to a true vertical line (TVL), and uses the term MXI-TVL, which is the linear measurement from the tip of the upper incisor to the true vertical line. The male upper central incisor tip is ideally -12 mm to the line and the female is at -9 mm (Fig. 7.11).

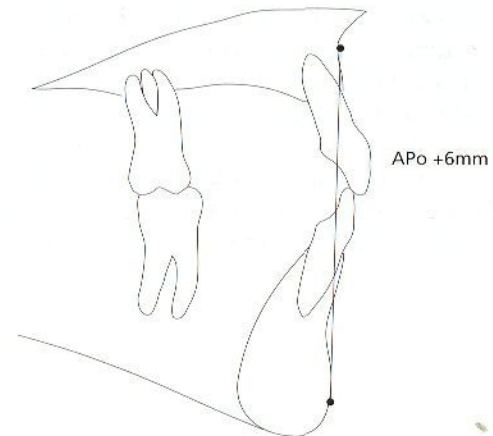


Fig. 7.10 In traditional orthodontic treatment planning, upper incisor position has been related to the APo line, with no difference in the normals between males and females.

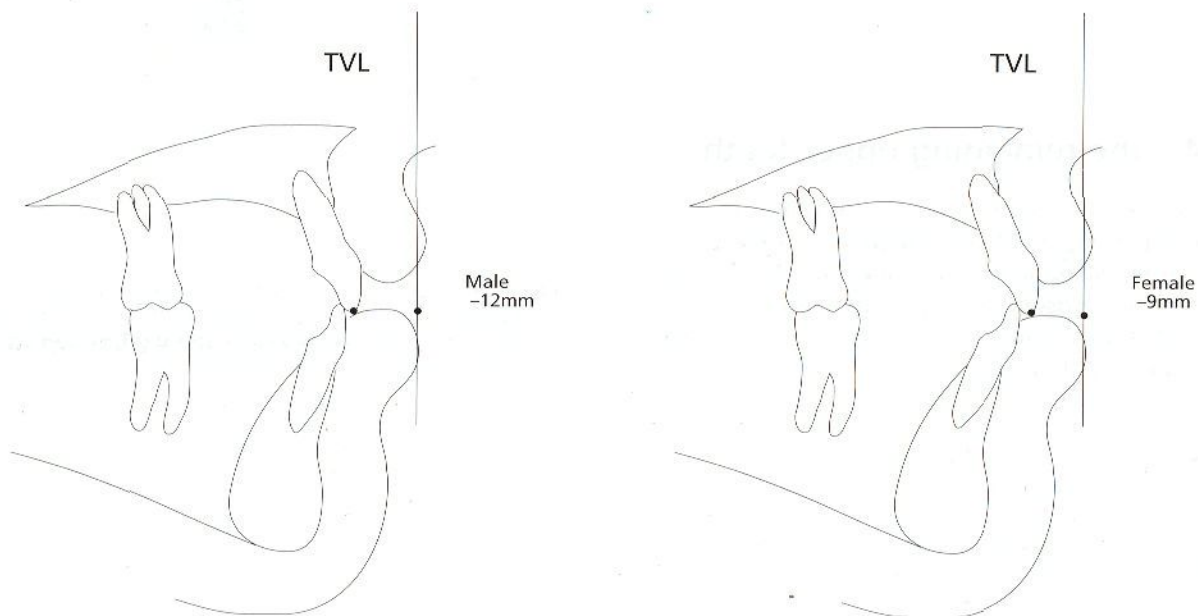


Fig. 7.11 The Arnett analysis relates upper incisor position to a true vertical line (TVL) and requires different ideals for males and females.

The torque component of PIP in Class II treatment

Traditionally in orthodontics upper incisor torque has been related to the maxillary plane, with a cephalometric value of 110° to 115° being a typical goal (Fig. 7.12). The Arnett analysis relates upper incisor torque to the maxillary occlusal plane, and lower incisor torque to the mandibular occlusal plane, with the male upper central incisor torque being ideally 58° and the female 57° (Fig. 7.13). More information on upper incisor torque is given on pages 174–176.

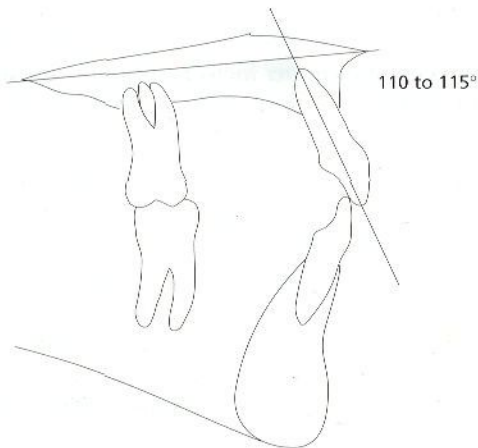


Fig. 7.12 In traditional orthodontic treatment planning, upper incisor torque is related to the maxillary plane.

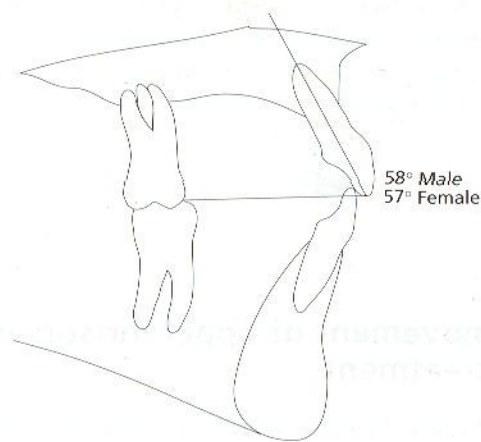


Fig. 7.13 The Arnett analysis relates upper incisor torque to the upper occlusal plane, and has slightly different values for males and females.

The vertical component of PIP in Class II treatment

The Arnett analysis quantifies the vertical positioning of upper incisors, and requires an overbite of 3mm, with upper incisor exposure being 4mm below the relaxed upper lip in males and 5mm in females (Fig. 7.14).

Orthodontic cephalometry has not provided clear goals for vertical positioning of the upper incisors. The high lip-line is a contributory factor in Class II/2 malocclusions, and there is an acknowledged need to procline and intrude upper incisors in such cases, to assist in stability.

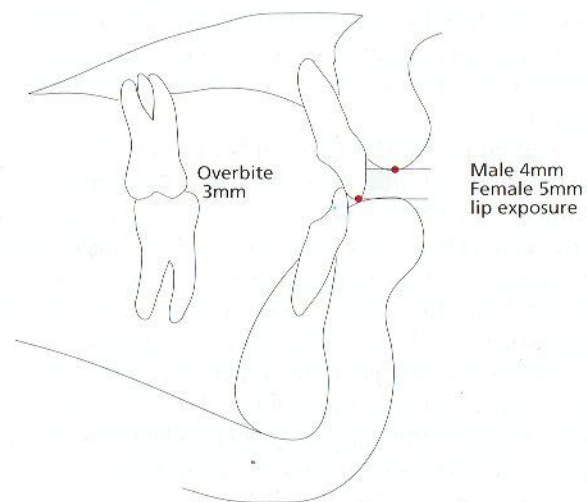


Fig. 7.14 Conventional orthodontic analysis does not provide clear goals for vertical upper incisor position. In contrast, the Arnett analysis quantifies incisor overbite and incisor exposure, with lips at rest.

UPPER INCISOR MOVEMENT IN CLASS II CASES

Having decided on a PIP for a case, controlled upper incisor tooth movement is needed to achieve the goal. It is helpful to consider the upper arch in isolation when planning treatment mechanics to position the upper incisors at PIP. It is helpful first to plan the upper incisor correction, and second to plan the lower incisor correction. This allows clear and systemized organization of treatment mechanics.

When planning upper arch tooth movements, the lower arch is relevant as a possible source of anchorage, if Class II mechanics are required. Also, proper overbite control is needed (Ch. 6), so that lower incisor position will not hinder upper arch incisor movement. These considerations apart, the maxillary incisor tooth movements can and should be planned without regard to the lower arch.

In the following pages, typical treatment situations will be discussed, giving details of the recommended MBT™ treatment mechanics for each required movement:

- Mesial movement of upper incisors.
- Distal movement of upper incisors in cases with upper anterior spacing.
- Distal movement of upper incisors after upper premolar extractions.
- Distal movement of upper incisors in non-extraction cases without spacing.

Mesial movement of upper incisors in Class II treatment

In Class II/2 cases, the upper incisors are typically too far back in the face. In the modern thinking, which is concerned more with the incisor position in the face, the Class II molar relationship (which Angle emphasized) is secondary to the retroclined upper and lower incisors. During leveling and aligning of the upper arch, the upper incisors move mesially, bringing them closer to the PIP, and the Angle's classification becomes Class II/1. In adolescent treatment, this ensuing Class II/1 case can normally be corrected by conventional orthodontics, but in some adult cases mandibular surgery will be required.

The required mesial change in upper incisor position is achieved mainly by tooth movement. In orthodontic cephalometry, the SNA is used to record the position of the maxillary skeletal base, and therefore this may suggest that mesial movement of the maxilla has contributed to the improved A/P position of the upper incisors. This is because 'A' point, which is a difficult cephalometric point to record, tends to follow the change in the upper incisor root position during Class II/2 leveling (Case DO, p. 212). The perceived change in 'A' point often gives a greater skeletal base discrepancy for the ensuing Class II/1 pattern than was evident in the starting Class II/2 malocclusion.

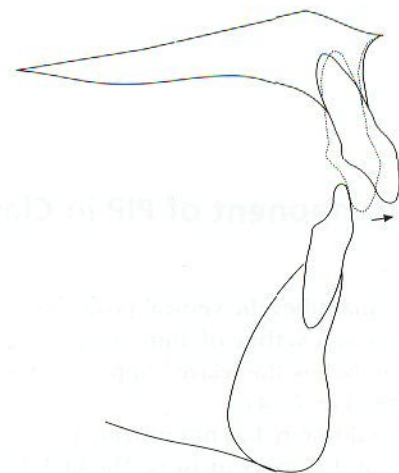


Fig. 7.15 'A' point is difficult to measure accurately. It tends to follow changes in position of upper incisor roots during upper arch alignment of Class II/2 cases.

In practical terms, the opening stages of Class II/2 cases may be managed in two ways:

1. Upper arch treatment may be started first, with no appliance (or else only lower molar bands) placed on the lower teeth (Fig. 7.16A). After reaching the rectangular steel working wire in the upper arch, the lower appliance may then be placed, and lower leveling commenced.
2. Upper and lower fixed appliances may be placed from the outset, with an upper acrylic bite plate being worn for the opening few months (Fig. 7.16B), to free the bite and prevent damage to the lower brackets (Case DO, p. 209). As upper arch leveling occurs, the removable bite plate gradually becomes a poor fit, and can be discarded after it has served its purpose.

Upper arch leveling and aligning are achieved by proceeding through the normal archwire sequences. Opening wires are normally multistrand, because there is often a need for anterior stepping to avoid excess force on the upper incisors at the start. Upper arch length increases during the first few months, and bendbacks should be 1 mm distal to the molar tubes to allow this in most cases (Fig. 7.16C). The typical early changes may be seen on Case DO, pages 208 & 209.

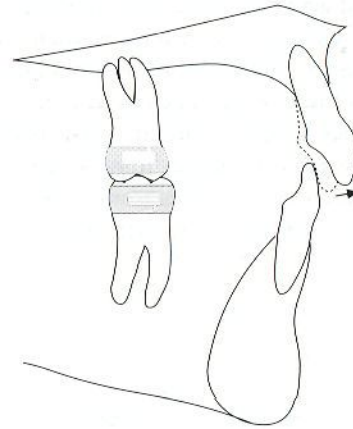


Fig. 7.16A Upper arch treatment may be started first in Class II/2 treatment.

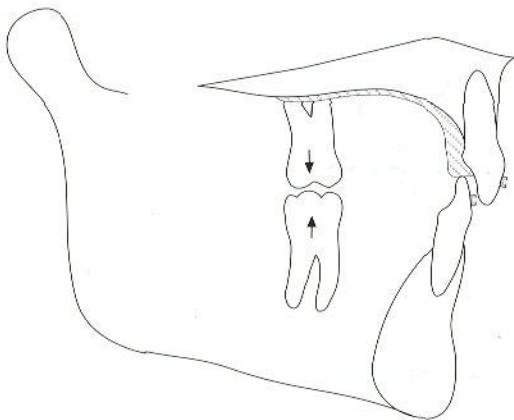


Fig. 7.16B An upper acrylic bite plate may be worn in the early months of Class II/2 correction. (Alternative methods of overbite control are discussed in Chapter 6, p. 134.)

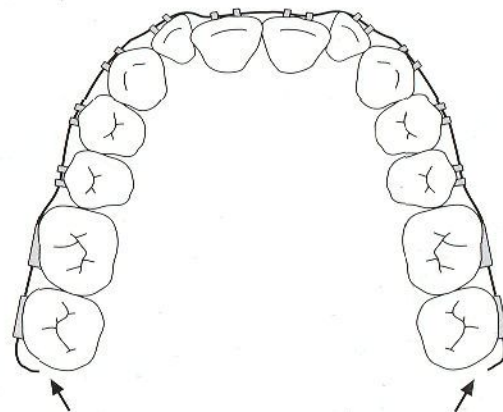


Fig. 7.16C Bendbacks should be 1 mm distal to molar tubes during leveling and aligning to allow arch length to increase.

Distal movement of upper incisors in cases with upper anterior spacing

Some Class II/1 cases have upper incisors which are demonstrably too far forward in the face. If this is associated with anterior spacing, it is a relatively routine procedure to gather up the upper incisors and retract them into the available space. (The mechanics have been likened to using a piece of rope to gather up a group of marbles on a tablecloth!)

Sliding mechanics are used, on a normal working steel rectangular wire, and active tiebacks achieve the necessary retraction and space closure, sometimes augmented by a light four-link anterior elastic chain. It is necessary to ensure that good lower arch leveling has been achieved beforehand. Appropriate anchorage support from an upper palatal bar, a sleeping headgear, or Class II elastics may be needed. Typical treatment mechanics are shown diagrammatically (Figs 7.17 & 7.18) and may be seen in Case DO, page 209.

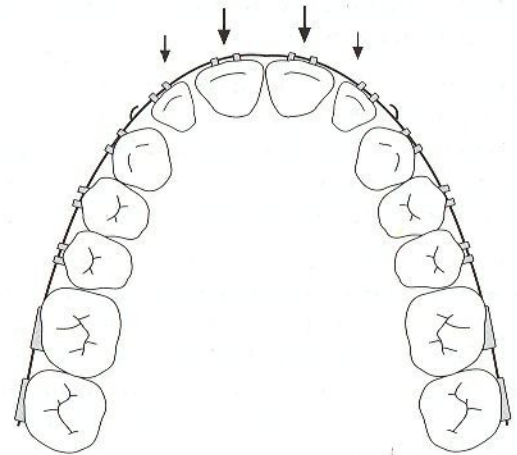


Fig. 7.17

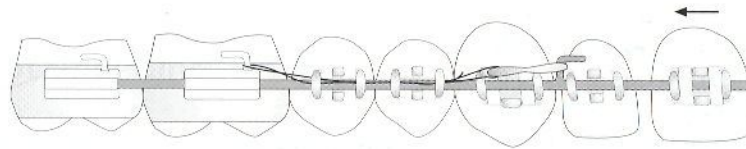


Fig. 7.18

Figs 7.17 and 7.18 If there is anterior spacing, sliding mechanics on a .019/.025 steel rectangular wire may be used to retract incisors and close spaces. Archwire hooks should be close to upper lateral incisor brackets, to avoid impingement onto canine brackets as the space closes. Anchorage support can be provided from a palatal bar, headgear, or Class II elastics.

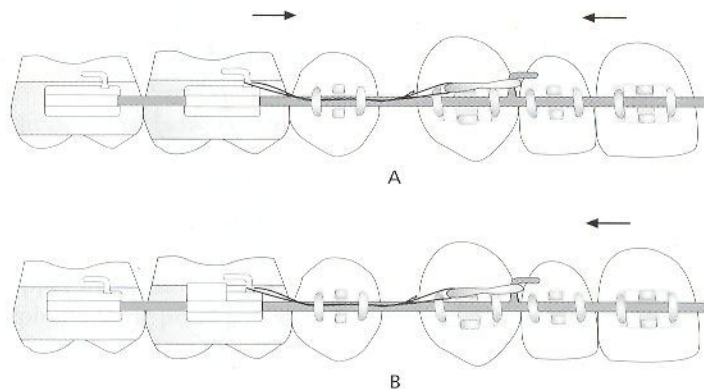


Fig. 7.19 Lateral view of sliding mechanics after upper first premolar extractions. Without anchorage support (A), reciprocal space closure normally occurs. With anchorage support (B), it is possible to retract the six anterior teeth into the space available and maintain A/P position of molars.

Distal movement of upper incisors after upper premolar extractions

Where possible, lower premolar extractions are generally avoided in Class II/1 cases, because of the need to maintain a mesial position for lower incisors. Therefore, few Class II/1 cases are treated by extraction of four premolars. If four premolars need to be taken, it is often appropriate to choose upper first premolars and lower second premolars, to assist treatment mechanics. A small number of cases may be treated to a Class II molar relationship,⁵ following extraction of two upper premolars (Case LJ, p. 184).

Sliding mechanics are used to retract upper incisors after premolar extractions, on a normal working steel rectangular wire. The retraction force is delivered from active tiebacks. A small amount of additional torque may need to be bent into the anterior region of the upper rectangular wire in the incisor region, and excess retraction force should be avoided. In this way, upper incisor torque control can be maintained during overjet reduction.

Appropriate anchorage support from either an upper palatal bar, a sleeping headgear, or Class II elastics may be needed (Fig. 8.12, p. 225), or from a combination of these. It is necessary to ensure that good lower arch leveling has been achieved beforehand, so that the overbite is minimal, and lower incisors will not interfere with the retraction process. Diagrams of typical treatment mechanics are shown (Figs 7.19 & 7.20) and may be seen in Case LJ on page 184.

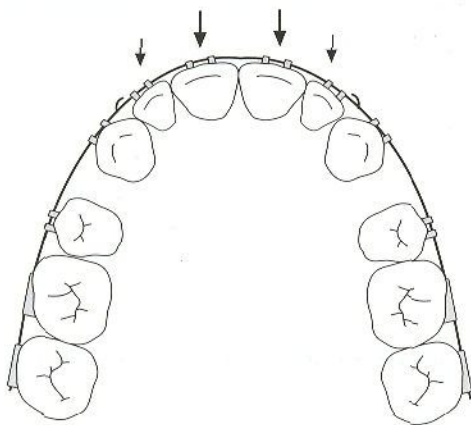


Fig. 7.20 Occlusal view of sliding mechanics, used to retract upper incisors after premolar extractions. With anchorage support from a headgear, a palatal bar, or Class II elastics, it is possible to maintain the position of upper molars and retract the six anterior teeth into the available space.

Distal movement of upper incisors in non-extraction cases without spacing

In some Class II/1 cases, it may be decided that the treatment should be on a non-extraction basis, and that the upper buccal segments need to be moved distally, to allow subsequent retraction of the upper incisors toward PIP. If the movement is minimal (1–3 mm), first molar rotation solves most of the problem (Fig. 7.21). A headgear and sliding jig are helpful in this situation. However, when the required movement is 3 mm or more, this becomes a challenging situation for the patient and orthodontist alike, irrespective of the treatment mechanics in use.

There will be a requirement to use sophisticated treatment mechanics to move upper molars and then premolars distally, using one of the many devices available for this purpose, normally supported with headgear. There are claims in the literature⁶ that this can be achieved on a regular basis, but only the most cooperative patient will achieve the planned tooth movements. Typical treatment mechanics are shown in sequences on pages 194 and 195.

This treatment approach results in a long treatment time, and the planned treatment goals are not always reached. Therefore, in some cases, the authors will abandon the non-extraction concept and consider loss of upper second molars.^{7–9} This greatly facilitates the treatment mechanics, and there is evidence¹⁰ that upper third molars subsequently erupt into good position in more than 80% of cases (Case DO, p. 215). If third molars are absent or poorly situated, then upper bicuspid extraction may be more appropriate.

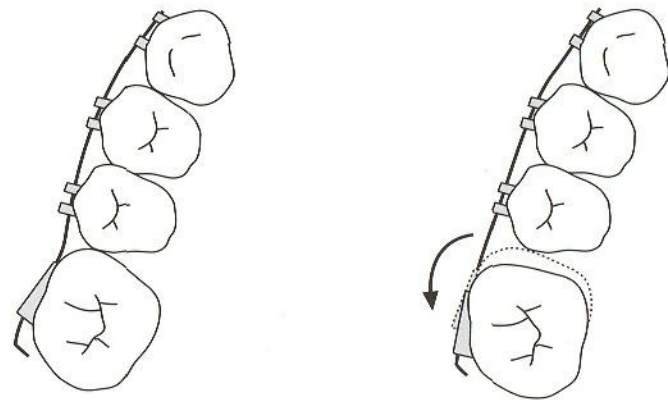


Fig. 7.21 Correction of upper first molar rotation can provide 1–3 mm of favorable distal movement of the buccal surfaces towards Class I. The bendback should be 2–3 mm distal to the end of the first molar tube, or there can be restriction of rotational correction.

Control of upper incisor torque

In June 2000, Fastlight¹¹ presented a discussion on the facial 'tetragon' consisting of the following four angles:

- Upper incisor to palatal plane
- Lower incisor to mandibular plane
- Inter-incisal angle
- Maxillary/mandibular plane angle (Fig. 7.22).

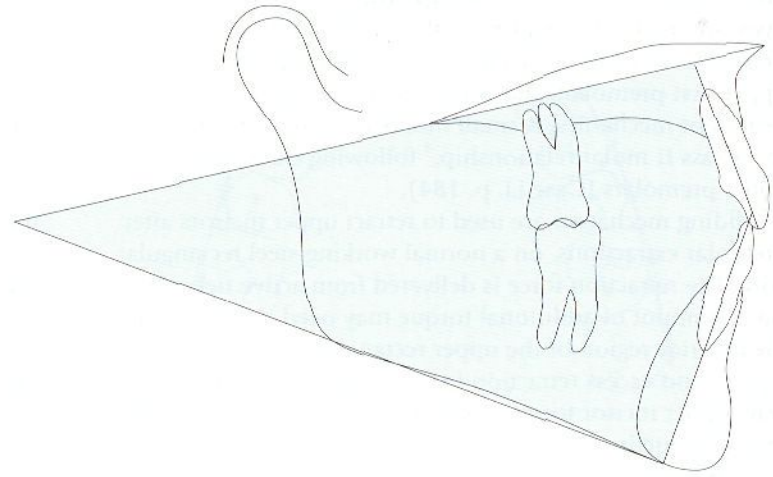


Fig. 7.22 Fastlight's tetragon.

By dividing the tetragon in half, two triangles are formed. The upper triangle has angles as follows:

- Palatal plane to occlusal plane
- Upper incisors to palatal plane
- Upper incisors to occlusal plane (Fig. 7.23).

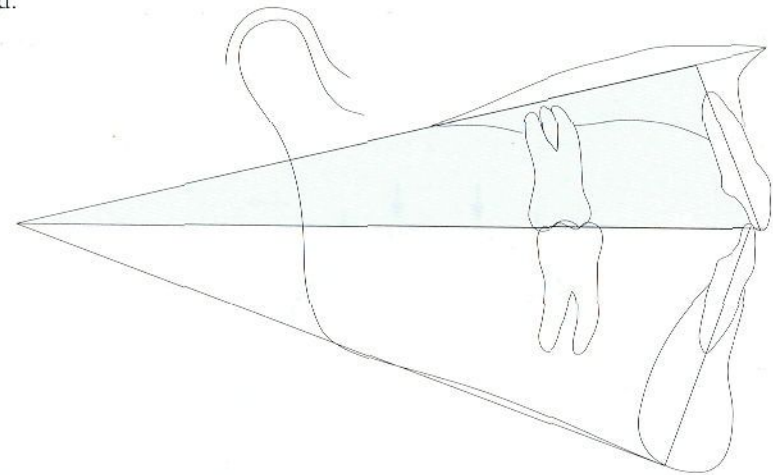


Fig. 7.23 Triangle formed from the upper part of Fastlight's tetragon.

The lower triangle has angles as follows:

- Mandibular plane to occlusal plane
- Lower incisors to occlusal plane
- Lower incisors to mandibular plane (Fig. 7.24).

www.allislam.net
Problem

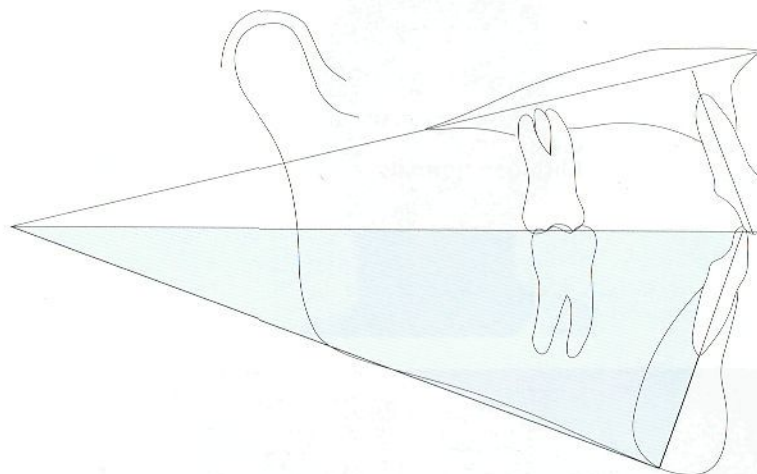


Fig. 7.24 Triangle formed from the lower part of Fastlight's tetragon.

Viewing the dental complex in this manner provides excellent information on incisor torque, and demonstrates that different normals need to be used, depending on the underlying skeletal pattern (Fig. 7.25).

Anterior torque compensation is typically necessary in high-angle Class I cases, and in cases with Class II or Class III skeletal bases, unless it is planned to use surgery to correct the skeletal pattern as part of treatment.

Part of the skill in Class II treatment planning lies in balancing the wish to avoid surgery against the unfavorable effect on facial profile which can result from incisor torque

compensation. How much compensation of torque can be accepted before it has to become a surgical case?

Incisor torque is controlled by the action of the rectangular .019/.025 wire in the .022/.028 bracket slots. The MBT™ bracket system has been designed to reduce the amount of wire bending needed. Despite this advance in bracket design, where necessary the orthodontist needs to accept the possible need to introduce bends into the steel rectangular wire, to add or reduce incisor torque, according to the requirements of individual cases (Case DO, p. 210).

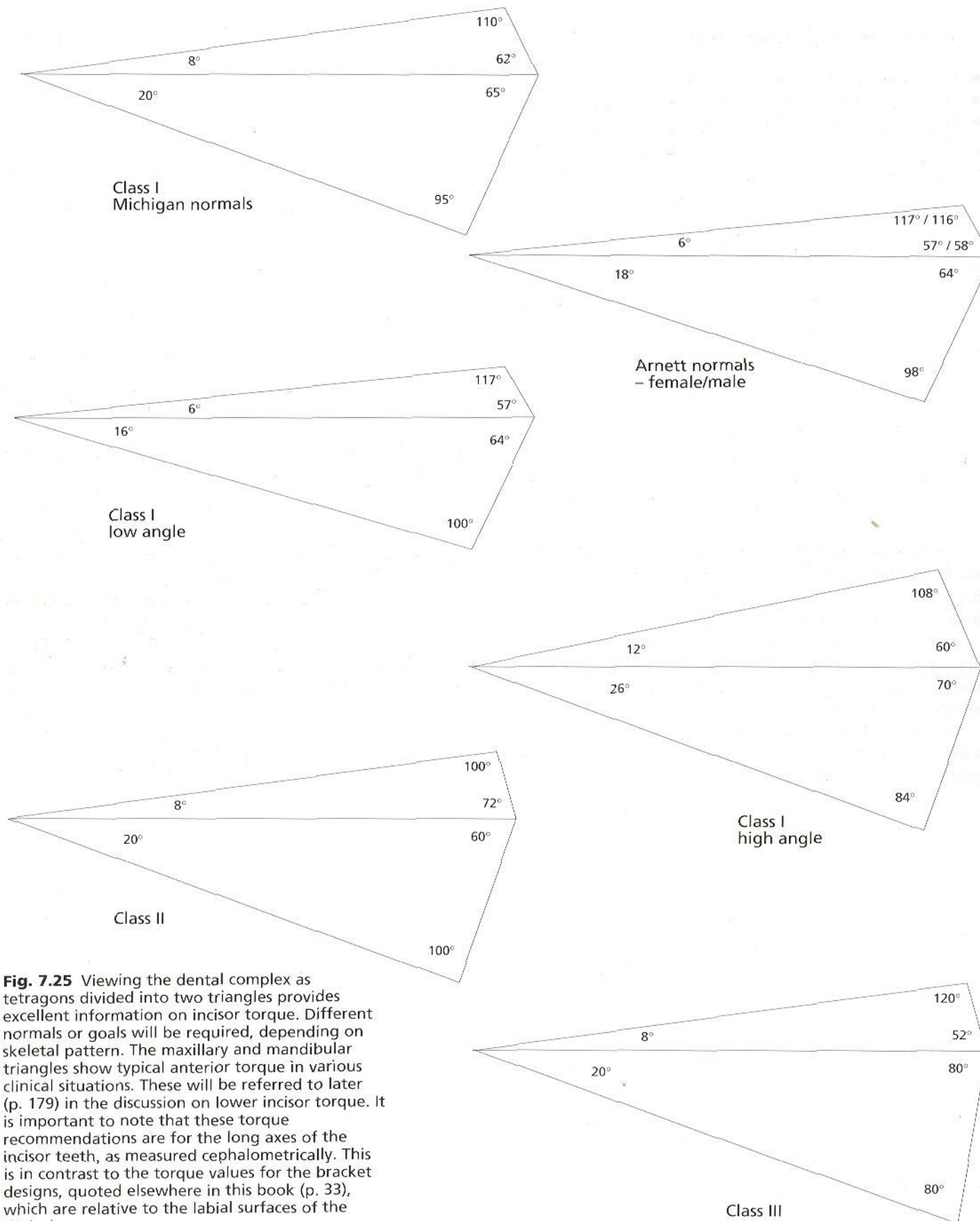


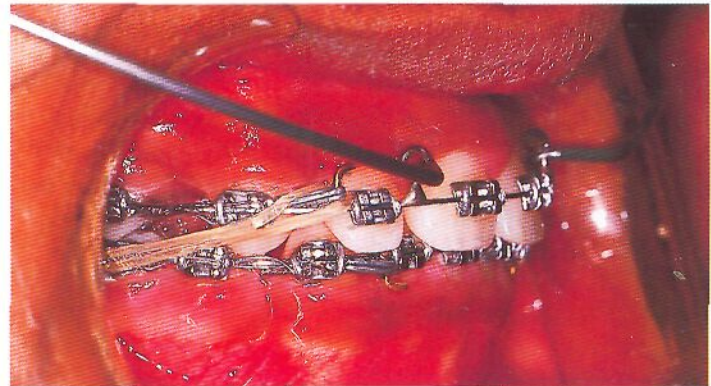
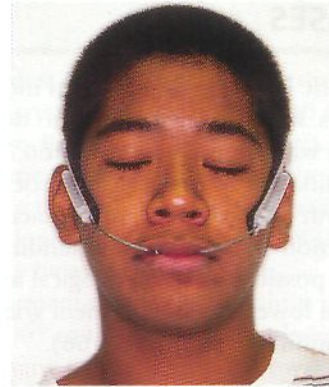
Fig. 7.25 Viewing the dental complex as tetragons divided into two triangles provides excellent information on incisor torque. Different normals or goals will be required, depending on skeletal pattern. The maxillary and mandibular triangles show typical anterior torque in various clinical situations. These will be referred to later (p. 179) in the discussion on lower incisor torque. It is important to note that these torque recommendations are for the long axes of the incisor teeth, as measured cephalometrically. This is in contrast to the torque values for the bracket designs, quoted elsewhere in this book (p. 33), which are relative to the labial surfaces of the clinical crowns.

Vertical control of incisors

In day-to-day orthodontic practice, there is a need to open deep anterior bites and to close anterior open bites. The treatment mechanics for this were explained in the previous chapter. As well as attempting to achieve a normal anterior overbite, the clinician should not lose sight of the desirability of meeting goals for upper incisor exposure relative to the upper lip, as proposed by Arnett. However, it needs to be borne in mind that the surgeon has a greater ability than the orthodontist to influence this aspect of correction.

Early in Class II/2 treatment, considerable upper incisor intrusion occurs during the leveling process, as progressively heavier wires are placed. Later, at the rectangular wire stage, in Class II/2 and other treatments, upper incisors can be slightly intruded, either by curve in the archwire or by the use of 'J' hook headgear, or by a combination of these. Upper incisors may be intruded relative to the lip line if the patient is prepared to wear a 'J' hook type of headgear (Case MP, p. 146), attached to specially soldered hooks on the upper steel rectangular wire (Figs 7.26 & 7.27). The mechanics are augmented if the upper archwire has 2 or 3 mm of curve of Spee.

An attempt may be made to extrude the upper incisors relative to the lip line in the following way. A steel rectangular .019/.025 wire with 2 or 3 mm of anti-Spee curve is tied into the lower arch. An upper wire of .014 round steel is then placed, with a 3 mm positive curve of Spee. Up-and-down anterior elastics (50 gm) can then be expected to produce some upper incisor extrusion.



Figs 7.26 and 7.27 Upper incisors may be intruded, relative to lip line, if the patient is prepared to wear a 'J' hook type of headgear. Careful contouring of the metal 'J' hooks is required so that they follow the contour of the cheeks.

POSITIONING OF LOWER INCISORS IN CLASS II CASES

Management of the lower incisors is often more difficult than the upper incisors. It may be a challenge to devise treatment mechanics which will achieve good position for the lower incisors, to coordinate with the upper incisor PIP. For growing individuals, growth prediction is not an exact science, due to the variable direction and quantity of mandibular growth. Despite this, it is possible to adopt a logical and systemized approach to reach lower incisor treatment goals, as set in Stage 2 of the planning sequence (p. 166).

Control of the antero-posterior position of lower incisors

In Class II treatment, the challenge is normally to bring the lower incisors sufficiently forward to coordinate them with the PIP for the upper incisors, as determined in Stage 1 of the treatment planning. This is true both in Class II/1 treatment, and in the second phase of Class II/2 treatment, after initial upper arch alignment has converted the case into effectively a Class II/1 malocclusion.

In orthodontic treatment mechanics, the lower incisor A/P position relative to the upper incisors can be changed by three main factors:

1. Movement of lower incisors in the mandibular bone (Fig. 7.28)
2. A change in the length of the mandible (Fig. 7.29)
3. A change in the A/P position of the mandible, due to changes in the position of the condyles in the fossae (Fig. 7.30).

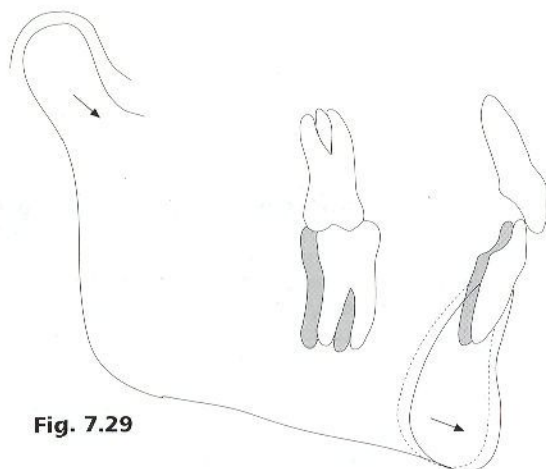


Fig. 7.28

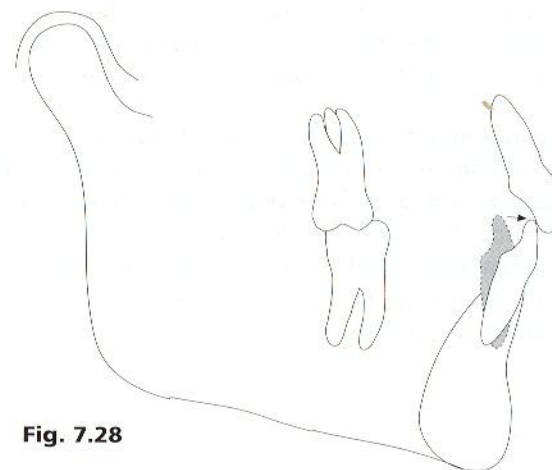


Fig. 7.28

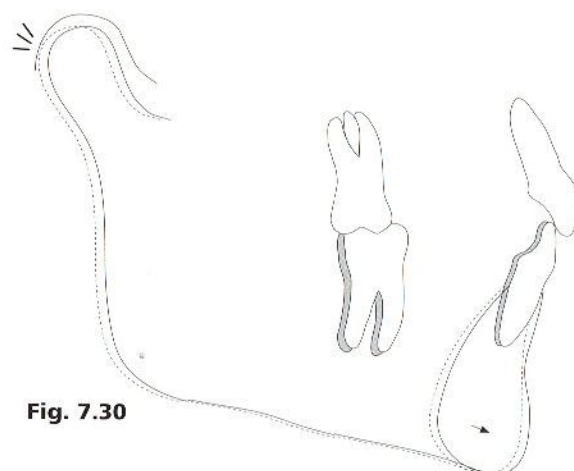


Fig. 7.30

Movement of lower incisors in the mandibular bone

The range of orthodontic tooth movement for lower incisors within the bony housing of the mandible is limited. Mesial bodily movement of lower incisors is normally not possible, due to the anatomy of the bone in the lower incisor area (Fig. 7.31). Therefore, any mesial movement of the lower incisor tips is mainly as a result of a change in torque (Fig. 7.32). A rule of thumb limit for this proclination is 100° to mandibular plane as set in the Class II mandibular triangle (p. 176). As these arbitrary limits are exceeded, there comes a perceived risk of instability, poor esthetics, or gingival problems.

Proclination of lower incisors from the starting position is normally necessary in Class II/2 cases, and many thumb-sucking Class II/1 cases, where the lower incisors are typically retroclined. It is accepted practice to move the lower incisors mesially in such cases. In Class II/1 cases with Class II skeletal bases, it is becoming more acceptable to procline lower incisors beyond the traditional 95° to mandibular plane and +2 mm to APo. Conventional orthodontic thinking was against this, because of the risk of gingival recession and relapse. However, gingival recession or periodontal disadvantage has been shown not to occur^{12,13} and relapse can be controlled with bonded retainers.

Therefore, modest proclination may be used to bring lower incisors into an acceptable relationship with PIP for upper incisors. Slight proclination of lower incisors may be acceptable for some Class II/1 cases with a mild Class II skeletal pattern. In this way, over-retraction of upper incisors, with consequent loss of upper lip concavity (leading to poor facial profile) may be avoided.

In Class II treatment the reasonable limit to lower incisor proclination is 100° to the mandibular plane, in most cases. Accordingly, in many Class II cases the lower incisors can be proclined forwards.

Geometrically, every 2.5° of proclination moves the lower incisor incisal edges forward by 1 mm (resulting in space gains of 2 mm for every 2.5° of proclination). Consequently, because of this space gain in Class II treatment, lower premolar extractions are not normally needed.

The -6° torque feature in the MBT™ lower incisor bracket is helpful in preventing excessive lower incisor proclination. A well-aligned lower arch with a .019/.025 steel rectangular wire tied in place can therefore often be used to support Class II elastics for upper incisor retraction, if the case needs this.

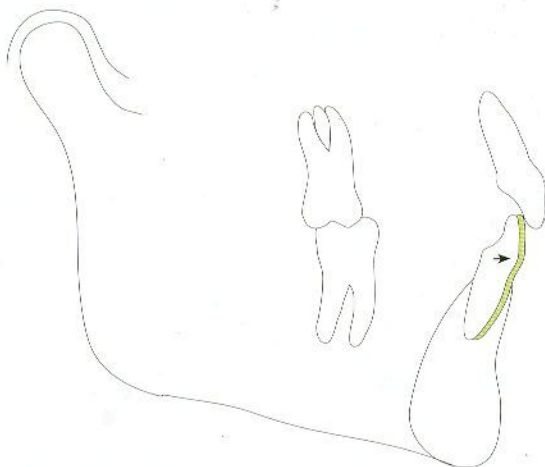


Fig. 7.31 The range of movement of lower incisors within the bony housing is limited.

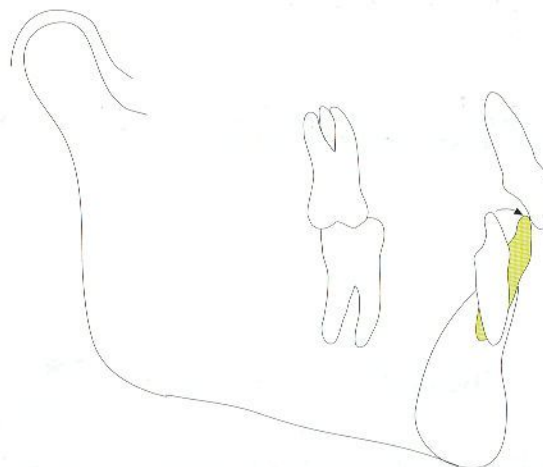


Fig. 7.32 Mesial movement of lower incisors is mainly due to proclination, with a change of torque.

Favorable change in the length or position of the mandible

Lower incisor mesial movement, relative to upper incisor PIP, will be augmented if there is a favorable change in the length of the mandible and hence a mesial change in 'B' point. This greatly assists treatment mechanics and in most cases enhances the facial profile of the result. Also, less lower incisor proclination will be needed if 'B' point moves forward during treatment.

An increase in mandibular length is therefore desirable for most Class II cases, but it is questionable whether there is any procedure which the orthodontist can follow which will achieve this. It is a large topic, but it may briefly be discussed under the following headings:

Mandibular growth

At the treatment planning stage for a growing individual, it is necessary to estimate the likely quantity and direction of mandibular growth, and hence projected changes in 'B' point. Generally low-angle cases show more favorable change in 'B' point than average-angle or high-angle cases (Fig. 7.33). More favorable late mandibular growth can be expected in growing boys than in girls.¹⁴

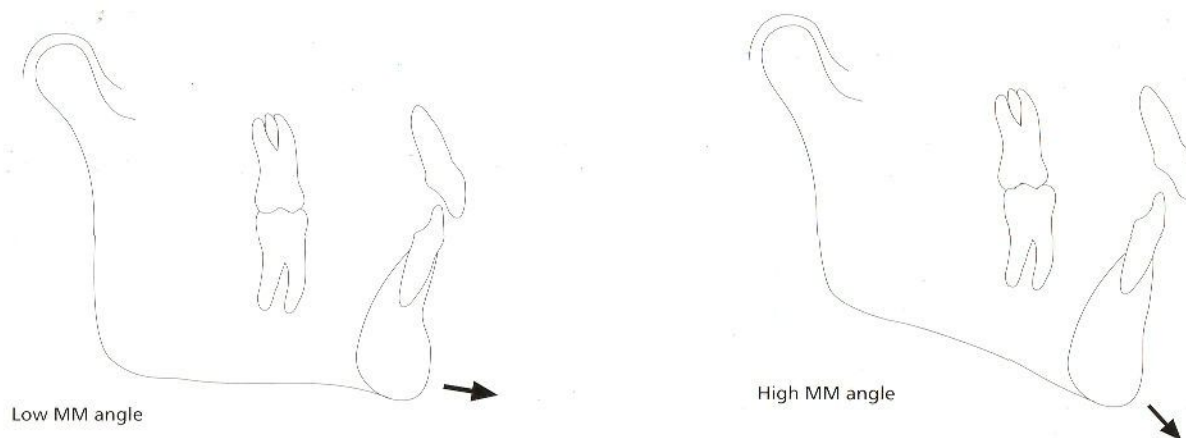


Fig. 7.33 It is necessary to make an informed estimate of the quantity and direction of mandibular growth in a growing individual at the treatment planning stage.

Augmentation of mandibular position with functional appliances?

The use of a functional appliance in the mixed dentition often produces a substantial and pleasing change for a young patient with a Class II malocclusion, with consequent improvement in the facial appearance. The reason for this pleasing change is that functional appliances have the potential to produce dental and skeletal change. They have the potential to procline lower incisors, retrocline upper incisors, favorably modify mandibular growth, and restrict maxillary growth.

Over the years, there has been much discussion and research to establish whether functional appliances can consistently increase the final length of the mandible, beyond what it would have been without the functional appliance. This is a difficult topic to investigate, and at present the research evidence does not confirm that it is possible to modify the quantity of mandibular growth using functional appliances.

Despite this, many orthodontists feel that functional appliances have a useful place in the management of Class II/1 malocclusions, because they produce a substantial early improvement for the patient (Case TS, p. 198), and can reduce the amount of treatment needed in the fixed appliance phase.

In 1998, Pancherz et al¹⁵ investigated 98 Class II/1 malocclusions treated with the Herbst appliance, to assess 'effective condylar growth'. This term was used to describe the summation of the condylar remodeling, glenoid fossa remodeling, and condylar repositioning changes. In individuals with anterior mandibular autorotation, they found relatively more forward change in chin position. In individuals with posterior mandibular autorotation, they found relatively more backward change in chin position.

In practical terms, if a functional appliance is to be used in a case, it is helpful to use it in the late mixed dentition. At this time, there is plenty of growth available, and it is possible to move straight into the fixed appliance phase, as the functional appliance phase ends. If the functional appliance is introduced in the early mixed dentition, it can be difficult and time consuming to manage the inevitable retention phase before fixed appliances can be placed.

Some functional appliance effects may accrue during the use of Class II elastics in a fully bracketed fixed appliance case. For example, this 'functional effect' is frequently seen when Class II elastics are used in the second phase of a Class II/2 treatment in a growing individual.

Favorable condylar repositioning of the mandible

In a few cases, the mandible may be positioned distally at the start of treatment, and then the condyles can be expected to reposition more mesially into a centered position, as treatment progresses. For example, in some Class II/2 treatments, there is the chance of a small but favorable mesial movement of 'B' point after the case has been converted to a Class II/1 malocclusion (Fig. 7.34), although this is difficult to confirm with research evidence (Case DO, p. 212).

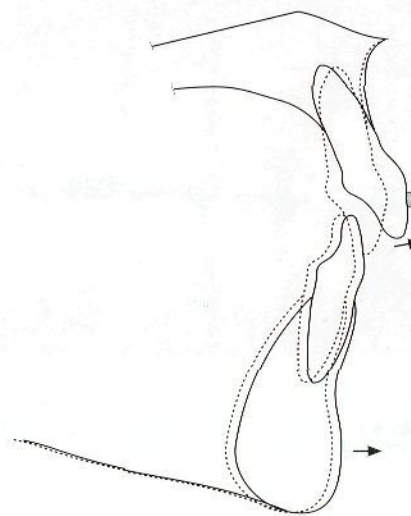


Fig. 7.34 During the opening stages of some Class II/2 treatments, there is a possibility of favorable mesial movement of 'B' point.

Orthopedic vertical control of the maxilla?

Although this is discussed as a method of achieving mesial movement of 'B' point, there seems to be little evidence that this is a useful orthodontic treatment procedure. It is difficult to achieve vertical control of the maxilla orthodontically.

Unfavorable condylar changes, causing a reduction in the length of the mandible

Effective shortening of the mandible can occur in some cases, due to changes in the condylar regions of the mandible (Fig. 7.35). In some instances, this will be identified as being due to idiopathic condylar resorption. This condition is fortunately rare, but can result in unfavorable downwards and backwards movement of 'B' point in response to changes in the condylar region. It is predominantly seen in female patients¹⁶ (Fig. 7.36).

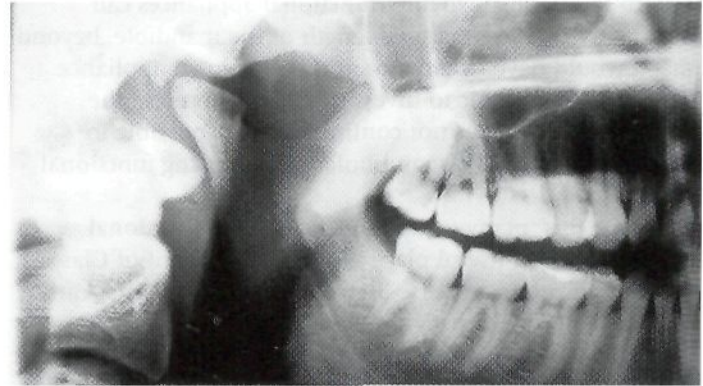


Fig. 7.35 Idiopathic condylar resorption occurs mainly in females. It is not well understood, and fortunately is rare. It can be unilateral. It causes a reduction in the length of the mandible, and this in turn results in an increase in overjet and anterior open bite.

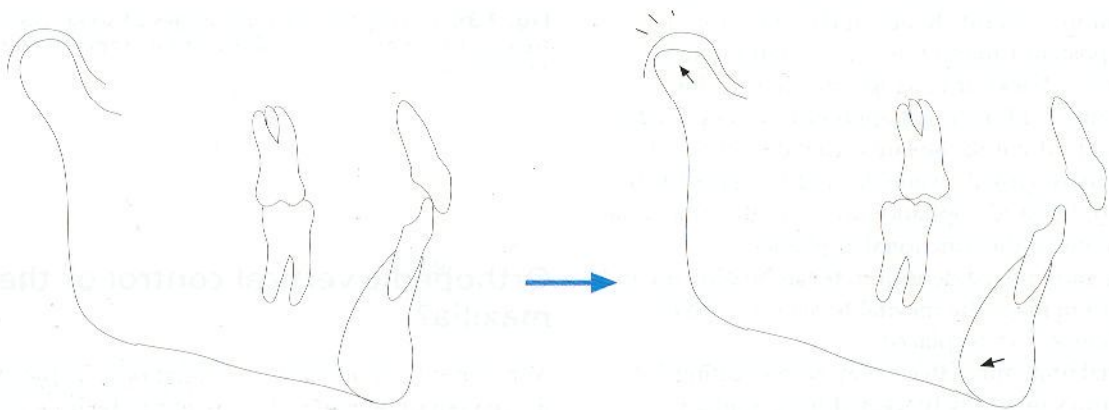


Fig. 7.36 Idiopathic condylar resorption is fortunately seldom seen, and is difficult to manage. It can result in unfavorable downward and backward movement of 'B' point during or after orthodontic treatment.

Unfavorable condylar repositioning of the mandible

During initial leveling and aligning of some Class II/1 malocclusions, the condyles may reposition distally, giving a substantial and unfavorable change in 'B' point. This results from a situation where centric occlusion and centric relation are not coincidental at the start of treatment (Fig. 7.37). Roth¹⁷ has advocated the early use of an acrylic splint to identify these individuals and establish true mandibular position before commencing treatment.

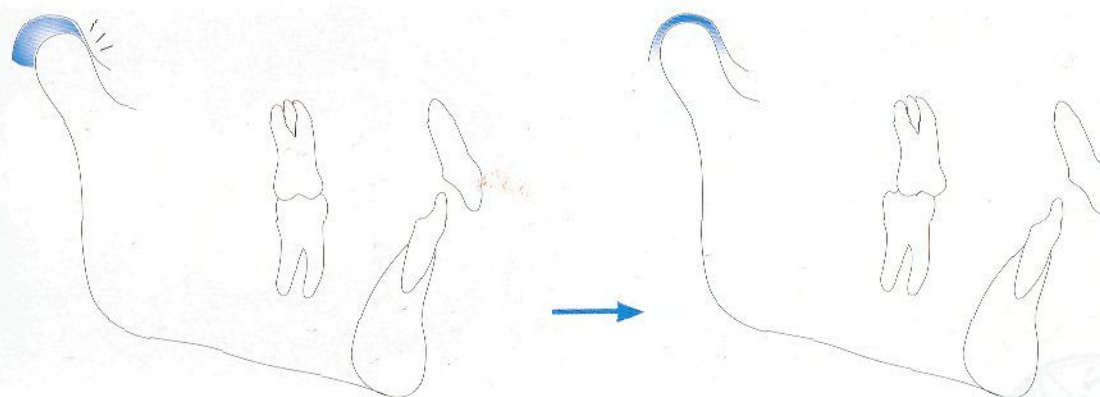


Fig. 7.37 If centric occlusion and centric relation are not coincidental at the start of treatment, the condyles will normally reposition distally during leveling and aligning. This gives a substantial and unfavorable change in 'B' point position.

REFERENCES

- 1 Tweed C H 1966 Clinical orthodontics. Mosby, St Louis
- 2 Arnett G W, Jalic J S, Kim J et al 1999 Soft tissue cephalometric analysis: diagnosis and treatment planning of dentofacial deformity. *American Journal of Orthodontics and Dentofacial Orthopedics* 116:239–253
- 3 Arnett G W, Bergman R T 1993 Facial keys to orthodontic diagnosis and treatment planning – part I. *American Journal of Orthodontics and Dentofacial Orthopedics* 103:299–312
- 4 Arnett G W, Bergman R T 1993 Facial keys to orthodontic diagnosis and treatment planning – part II. *American Journal of Orthodontics and Dentofacial Orthopedics* 103:395–411
- 5 Bennett J, McLaughlin R P 1997 Orthodontic management of the dentition with the preadjusted appliance. Isis Medical Media, Oxford (ISBN 1 899066 91 8) pp. 233–250. Republished in 2002 by Mosby, Edinburgh (ISBN 07234 32651)
- 6 Gianelly AA 1998 Distal movement of the maxillary molars. *American Journal of Orthodontics and Dentofacial Orthopedics* 114:66–72
- 7 Graber T M 1969 Maxillary second molar extraction in Class II malocclusion. *American Journal of Orthodontics* 56:331–353
- 8 Bishara S E, Ortho D, Burkey P S 1986 Second molar extractions: a review. *American Journal of Orthodontics and Dentofacial Orthopedics* 89:415–424
- 9 Wilson W L, Wilson R C 1981 Modular orthodontics manual. Denver: Rocky Mountain Orthodontics
- 10 Basdra E K, Stellzig A, Komposch G 1996 Extraction of maxillary second molars in the treatment of Class II malocclusion. *Angle Orthodontist* 66(4):287–292
- 11 Fastlight J 2000 Tetragon: a visual cephalometric analysis. *Journal of Clinical Orthodontics* 34(6):353–360
- 12 Årtun J, Osterberg S K, Kokich V G 1986 Long-term effect of thin interdental alveolar bone on periodontal health after orthodontic treatment. *Journal of Periodontology* 57:341–346
- 13 Ruf S, Hansen K, Panherz H 1998 Does orthodontic proclination of lower incisors in children and adolescents cause gingival recession? *American Journal of Orthodontics and Dentofacial Orthopedics* 114:100–106
- 14 Riolo M et al 1974 Atlas of craniofacial growth. Center for Human Growth and Development, University of Michigan
- 15 Panherz H, Ruf S, Kohlas P 1998 'Effective condylar growth' and chin position changes in Herbst treatment: a cephalometric roentgenographic long-term study. *American Journal of Orthodontics and Dentofacial Orthopedics* 114:437–446
- 16 Wolford L M, Cardenas K 1999 Idiopathic condylar resorption: diagnosis, treatment protocol and outcomes. *American Journal of Orthodontics and Dentofacial Orthopedics* 116:667–677
- 17 Roth R 1972 Gnathological concepts and orthodontic treatment goals. In: Jarabak J R, Fizzell, J A (eds) *Technique and treatment with light wire appliances*, 2nd edn. Mosby, St Louis pp. 1160–1223

CASE LJ

An adult female patient, aged 23.1 years at start of treatment. The skeletal pattern was slightly Class II (ANB 5°) and low angle (MM 20°)

The buccal occlusion was Class II bilaterally, with a deep bite and upper incisor crowding and rotations. All permanent teeth were present, including unerupted third molars. The possibility of a combined orthodontic/orthognathic surgical approach was discussed with the patient, but she wished to avoid surgery. Accordingly, a decision was made to extract all the third molars and the upper first premolars, and treat the case to a Class II buccal occlusion.

All the teeth were banded or bracketed except the lower incisors. Lower incisor separation and enamel reduction were carried out.



Fig. 7.38

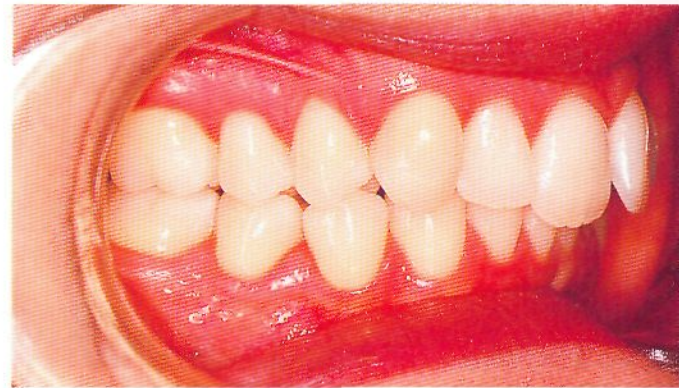


Fig. 7.41

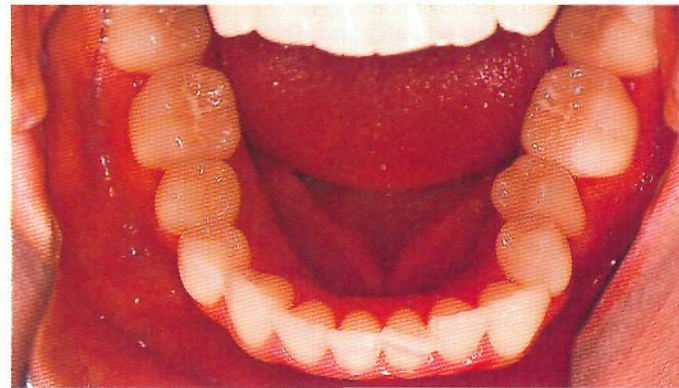


Fig. 7.44

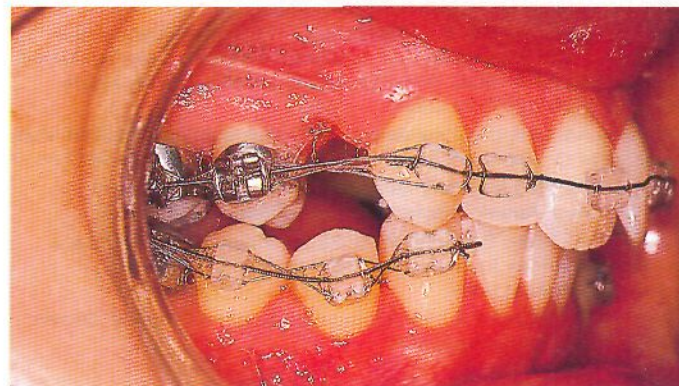


Fig. 7.47



Fig. 7.39

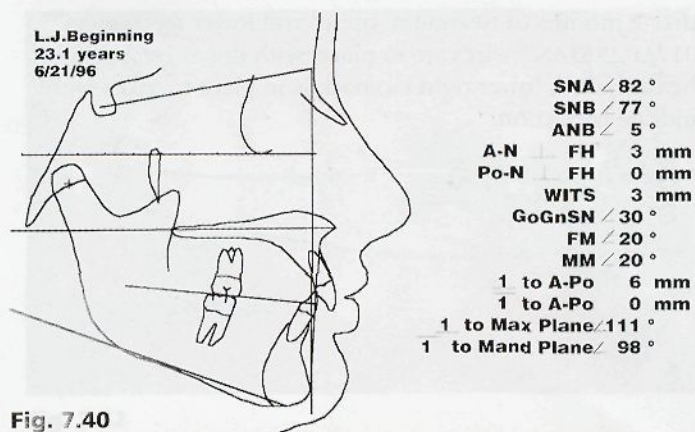


Fig. 7.40



Fig. 7.42

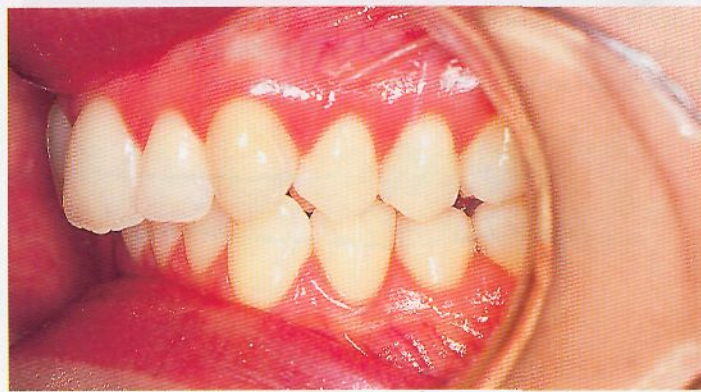


Fig. 7.43

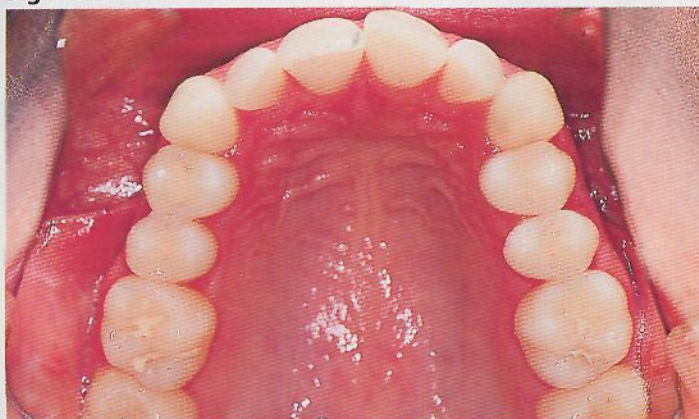


Fig. 7.45

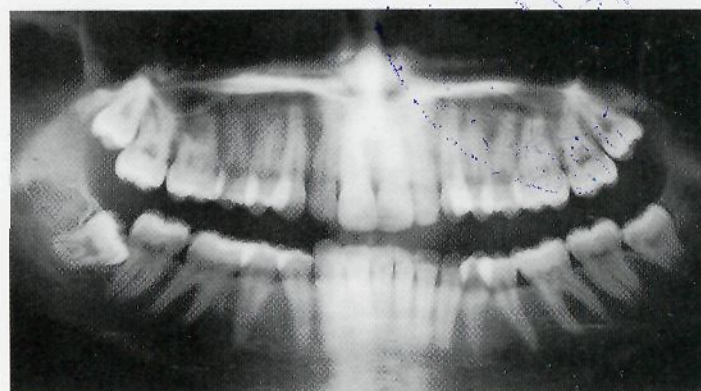


Fig. 7.46

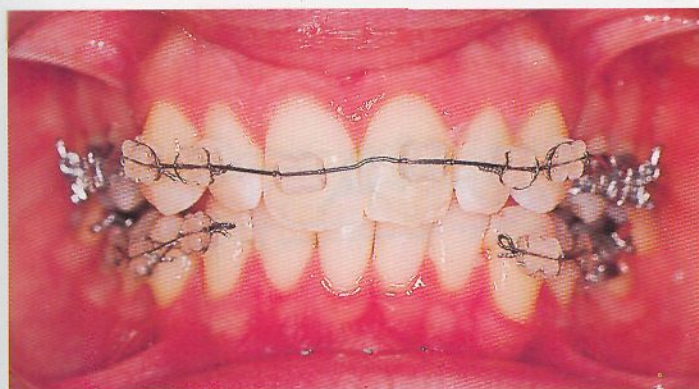


Fig. 7.48

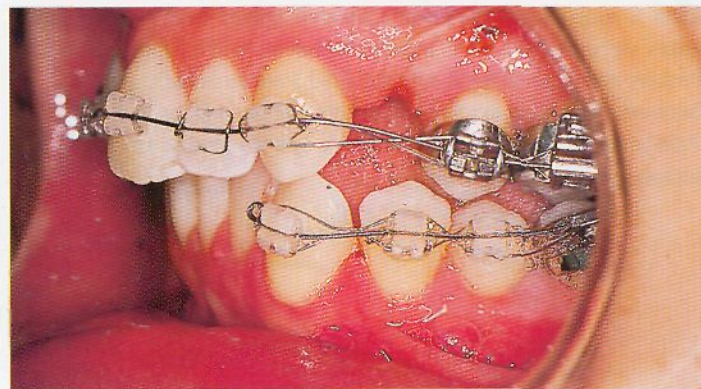


Fig. 7.49

After 2 months of treatment, upper and lower rectangular .017/.025 HANT wires are in place, with upper lacebacks to the canines. A lower right laceback is in place to assist with midline correction.

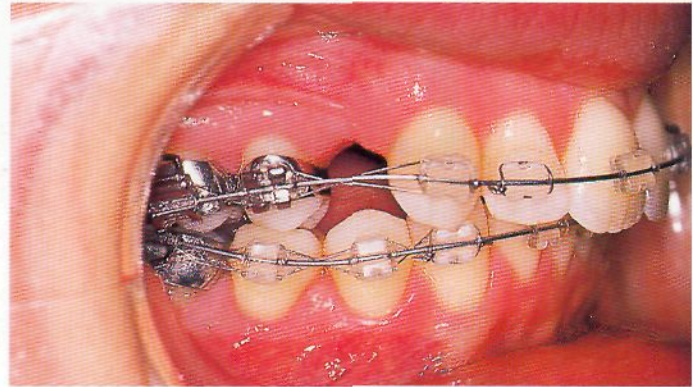


Fig. 7.50

After 5 months of treatment, lower first molar bands were repositioned. Upper and lower rectangular HANT wires are in place, and lacebacks have been discontinued.

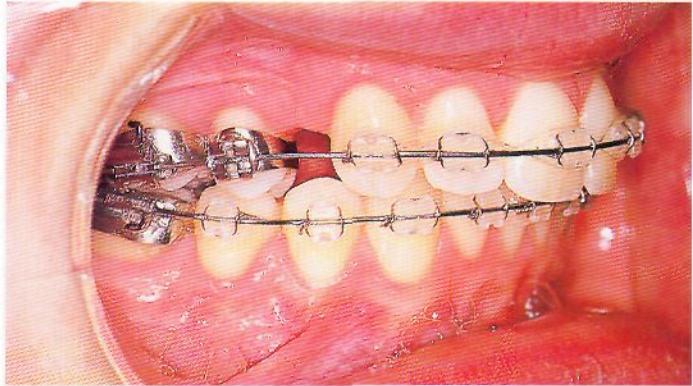


Fig. 7.53

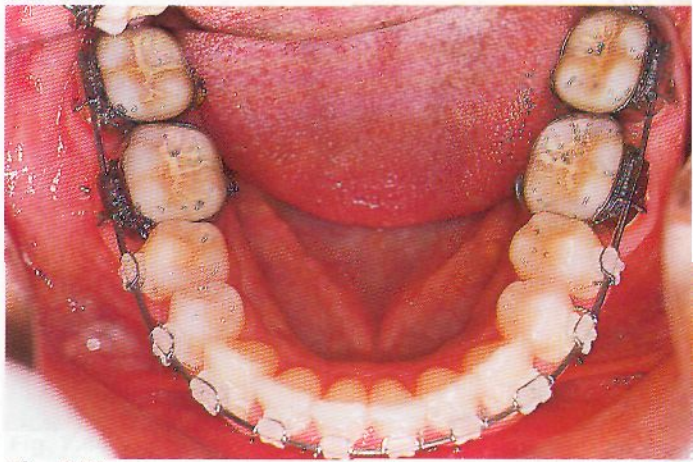


Fig. 7.56

After 8 months of treatment, normal upper steel rectangular wires were placed, with passive tiebacks in the upper arch. Passive tiebacks (Figs 7.59 and 7.61) are normally placed for between four and six weeks. Active tiebacks (Figs 7.58, 7.62, 7.64) may then be used to achieve space closure and overjet reduction.



Fig. 7.59



Fig. 7.51

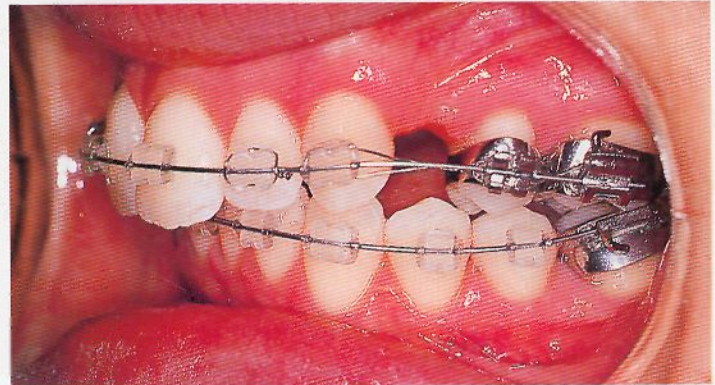


Fig. 7.52



Fig. 7.54

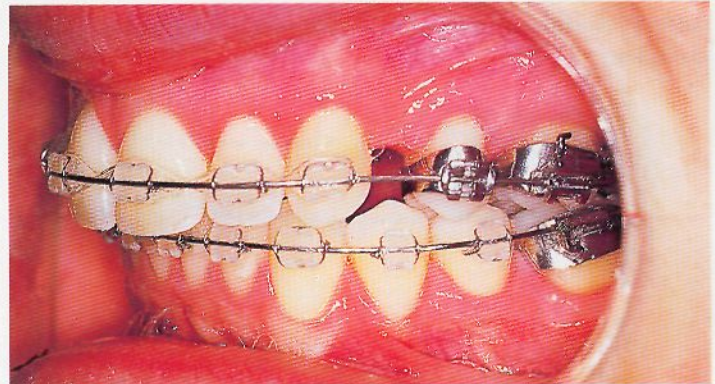


Fig. 7.55

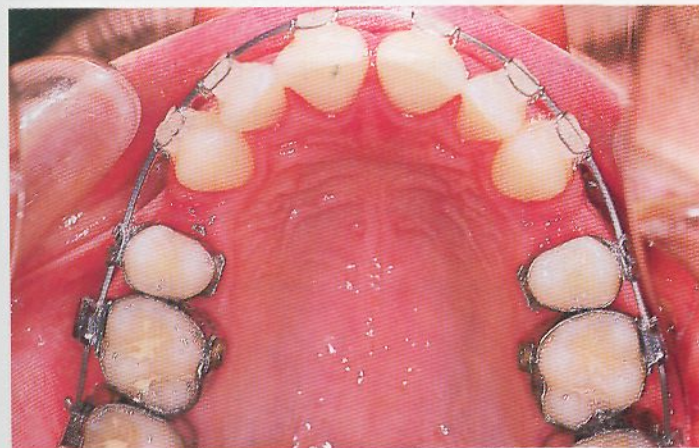


Fig. 7.57

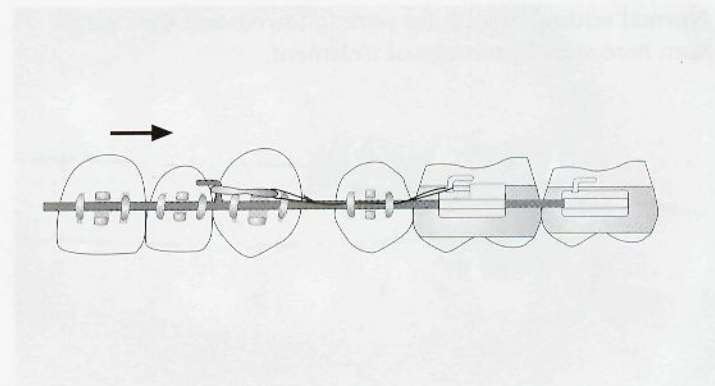


Fig. 7.58



Fig. 7.60



Fig. 7.61

One year into treatment, and upper space closure with torque control is being achieved with active tiebacks and a steel rectangular wire.

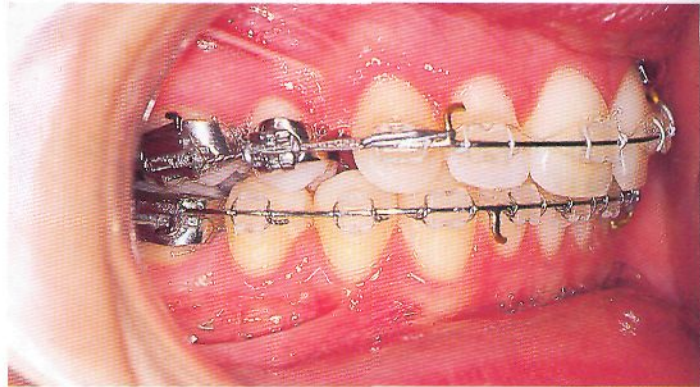


Fig. 7.62

After 15 months of treatment, upper space closure was almost complete.

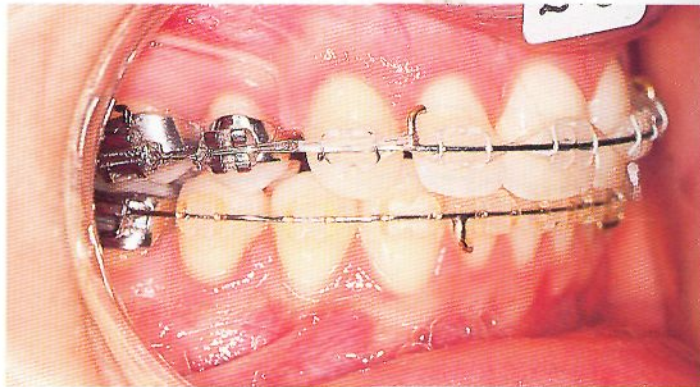


Fig. 7.65

Normal settling procedures were followed, and the case is seen here after 20 months of treatment.

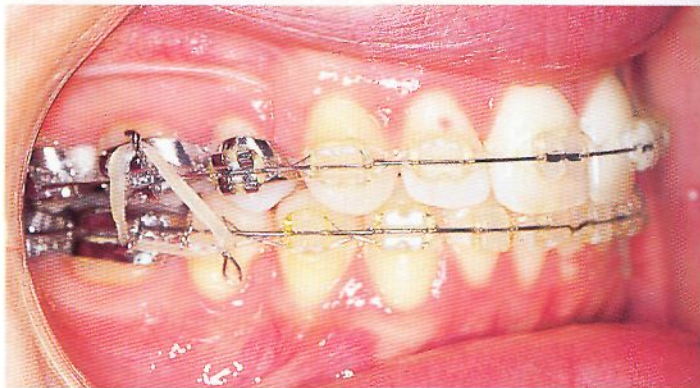


Fig. 7.68

The case after one month of settling.



Fig. 7.71

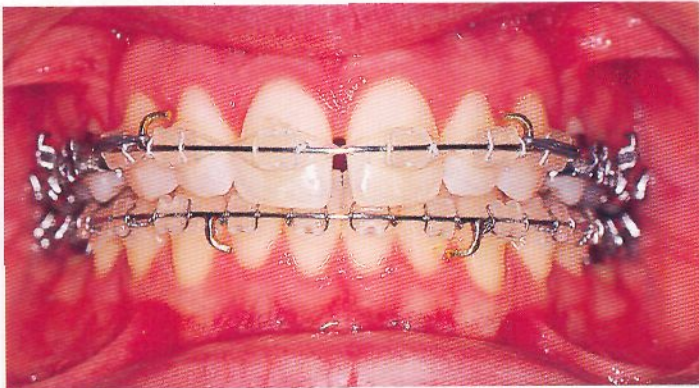


Fig. 7.63

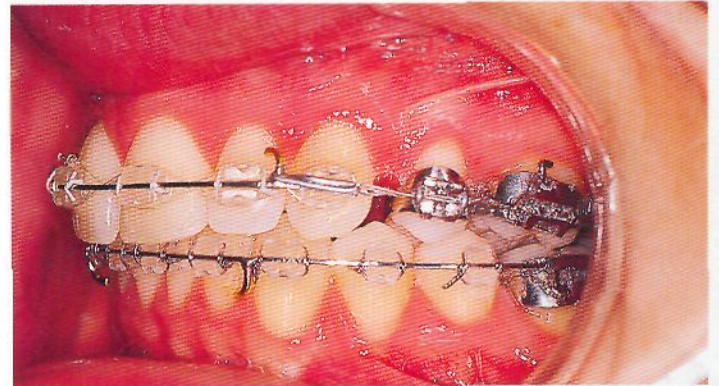


Fig. 7.64



Fig. 7.66

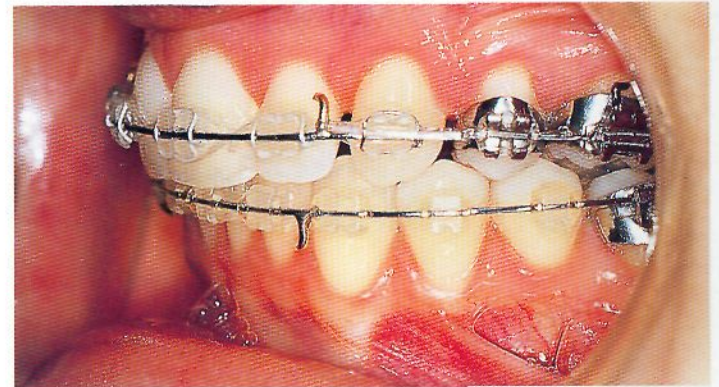


Fig. 7.67

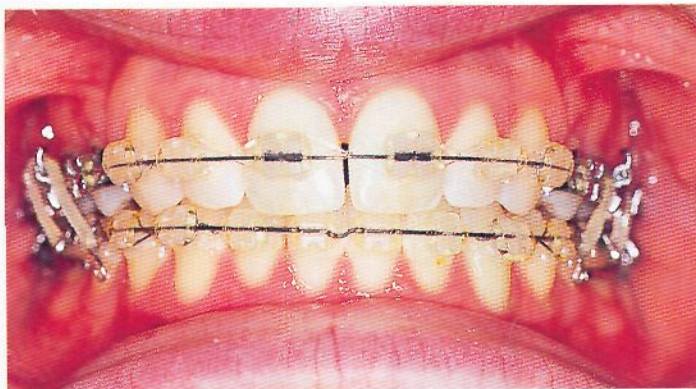


Fig. 7.69

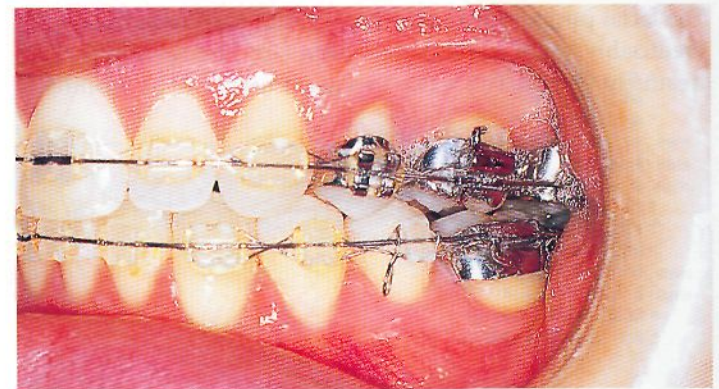


Fig. 7.70

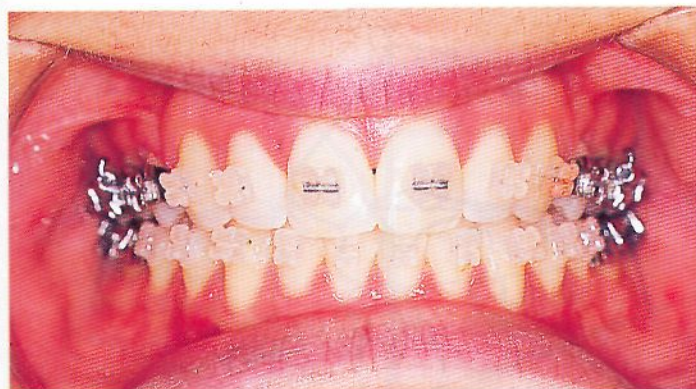


Fig. 7.72



Fig. 7.73

The case after appliance removal.



Fig. 7.74

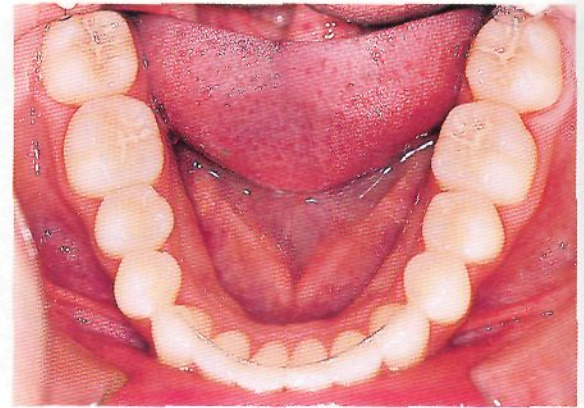
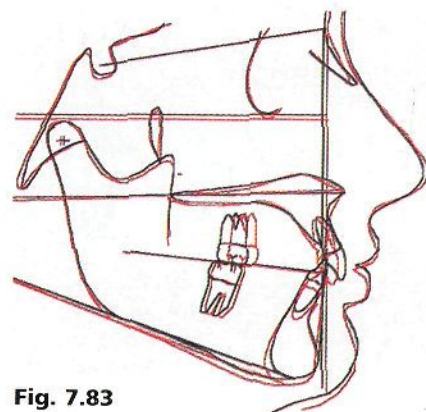


Fig. 7.77

The facial profile shows pleasing balance and harmony. Predictably, there was little cephalometric change during the treatment period. The active treatment time was 21 months.



Fig. 7.80



SN at S

**L.J.Begin
L.J.Final**

Fig. 7.83

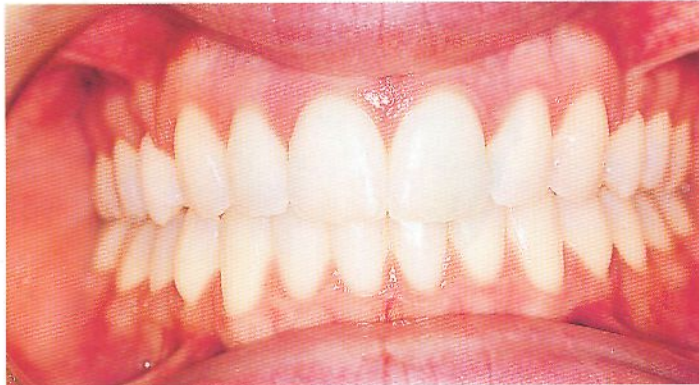


Fig. 7.75



Fig. 7.76

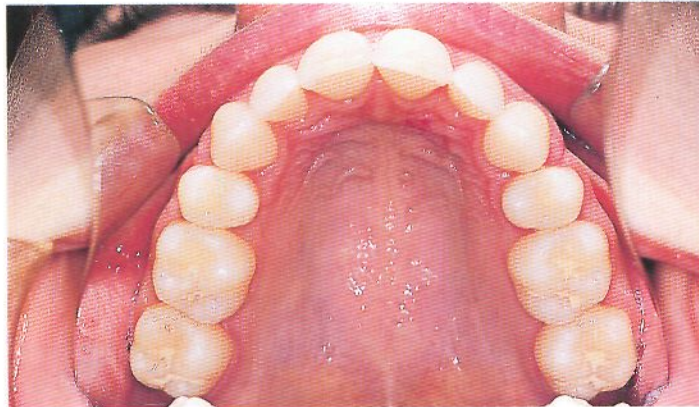


Fig. 7.78

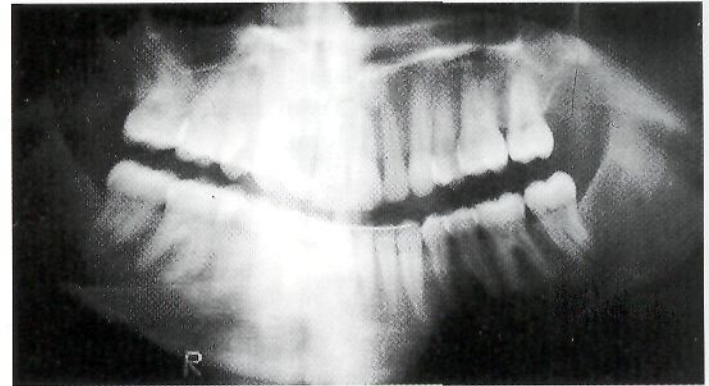


Fig. 7.79



Fig. 7.81

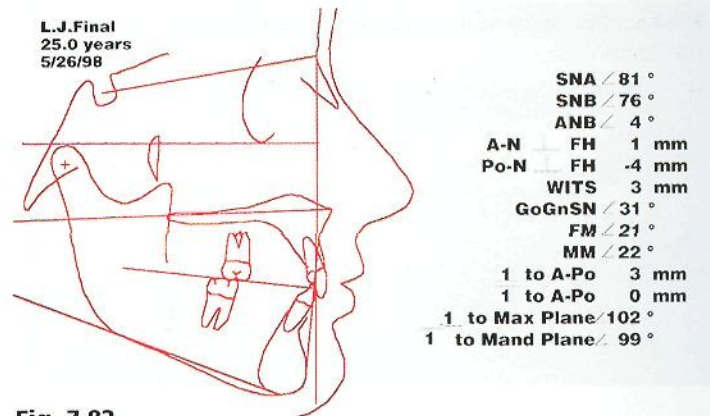


Fig. 7.82

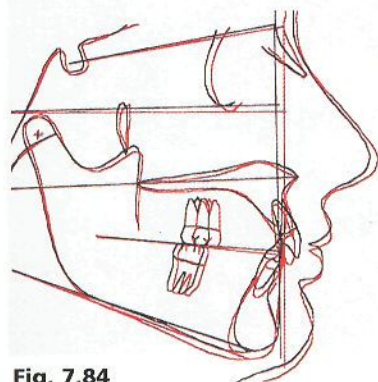


Fig. 7.84

**Palatal Plane &
Palate Curvature**

**L.J. Final
L.J. Final**

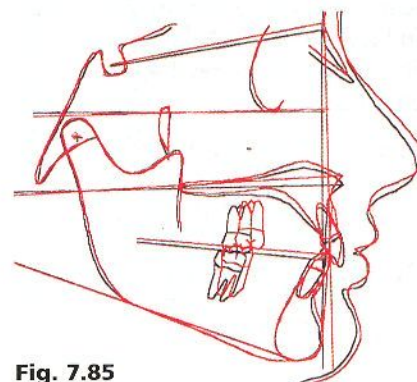


Fig. 7.85

**Mand. Symphysis
& Mand. Plane**

**L.J. Begin
L.J. Final**

CASE TC

Male patient, aged 11.4 years, with a Class I skeletal relationship (ANB 3°) and a slightly low-angle pattern (MM 23°). He was slightly Class II dentally. This type of malocclusion is frequently seen.

The incisor relationship was close to normal, although there was a midline discrepancy of 2 mm and a lack of space for erupting upper canines. The molar relationship was 3 mm Class II on the right and 2 mm Class II on the left. It was decided to treat to a square arch form.

Radiographs showed all permanent teeth developing normally.

At the start of treatment, the first molars were banded, and the patient was asked to wear a sleeping headgear. The lower arch was fully bracketed, and leveling and aligning was commenced with a .016 HANT wire. An upper sectional multistrand wire was placed for the upper incisors.



Fig. 7.86



Fig. 7.89

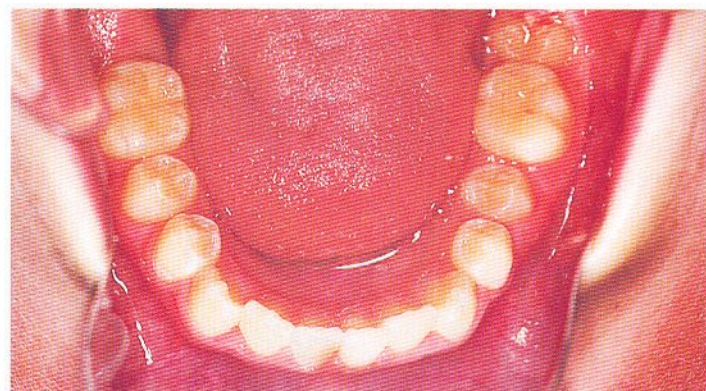


Fig. 7.92

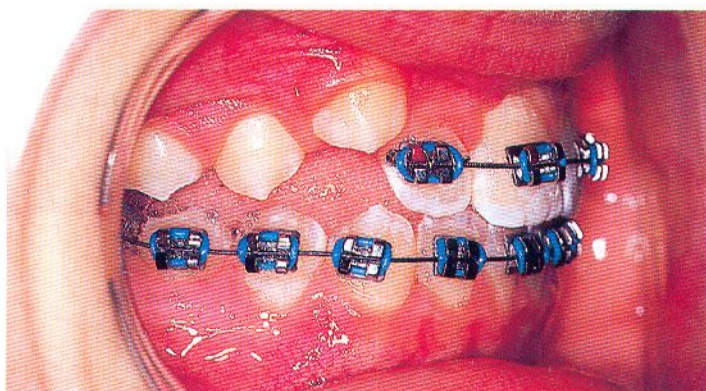
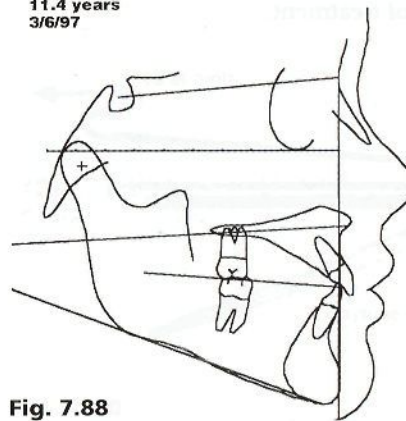


Fig. 7.95



Fig. 7.87

T.C. Beginning
11.4 years
3/6/97



SNA	/	85°
SNB	/	82°
ANB	/	3°
A-N	FH	0 mm
Po-N	FH	0 mm
WITS		1 mm
GoGnSN	/	26°
FM	/	20°
MM	/	23°
1 to A-Po		4 mm
1 to A-Po		0 mm
1 to Max Plane	/	118°
1 to Mand Plane	/	92°

Fig. 7.88



Fig. 7.90

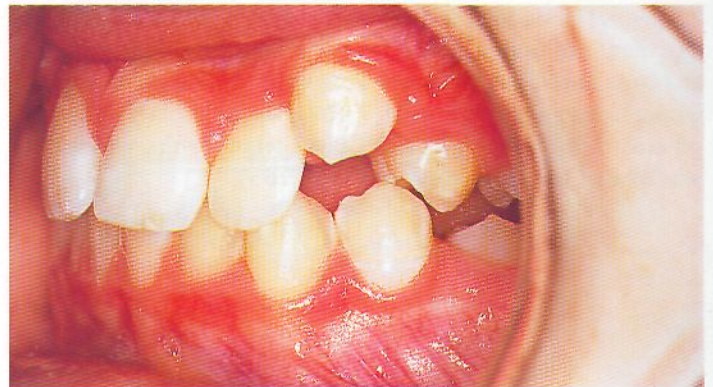


Fig. 7.91



Fig. 7.93

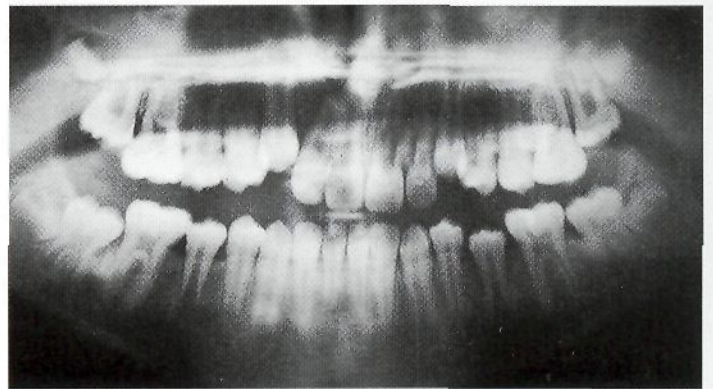


Fig. 7.94

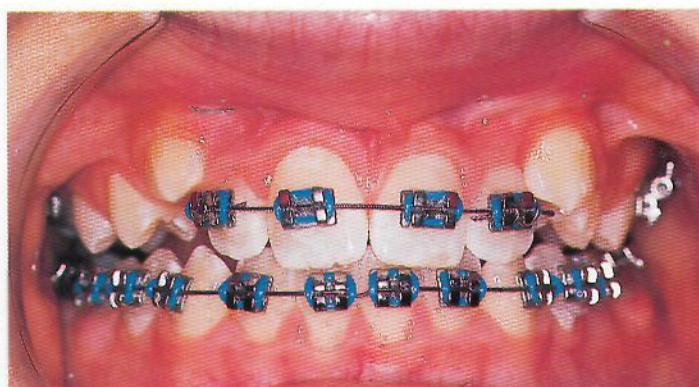


Fig. 7.96

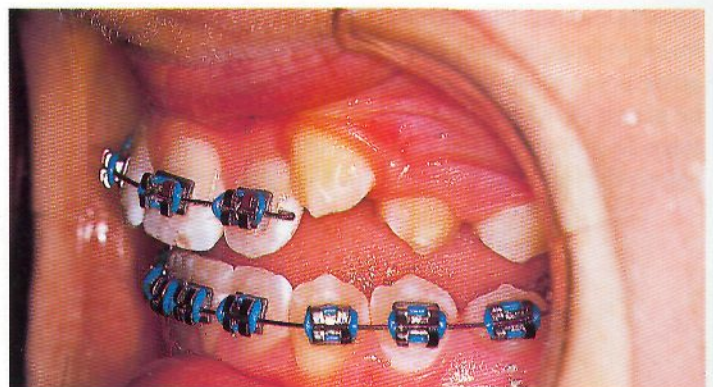


Fig. 7.97

Occlusal views at the start of treatment.

Sequential views after 2 months, 4 months, and 9 months of treatment. An upper sliding jig was placed on a .020 round archwire, and Class II elastics were worn during the daytime, with a headgear at night (Fig. 7.102). Upper molars and premolars moved distally to a Class I relationship, and space was created for upper canines (Fig. 7.103).

Occlusal views after 9 months of treatment. A lower lingual arch was maintained to support lower molars so that mesial movement did not occur in response to the Class II elastics. A lower steel rectangular wire was in place, with passive tiebacks.

After 18 months of treatment, the case is seen with upper and lower rectangular steel wires, passive lower tiebacks, and active upper tiebacks. Additional torque frequently needs to be placed in the anterior part of the upper archwire at this stage, to achieve palatal root torque of upper incisors and to correct the buccal occlusion (p. 284).

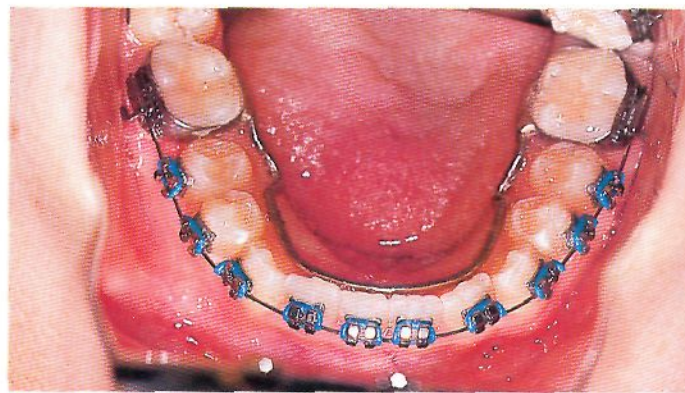


Fig. 7.98

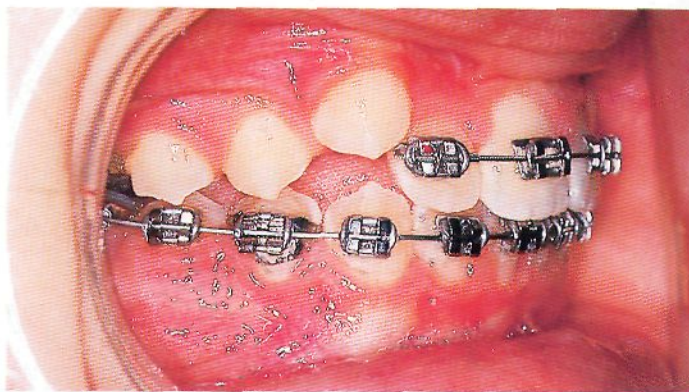


Fig. 7.101

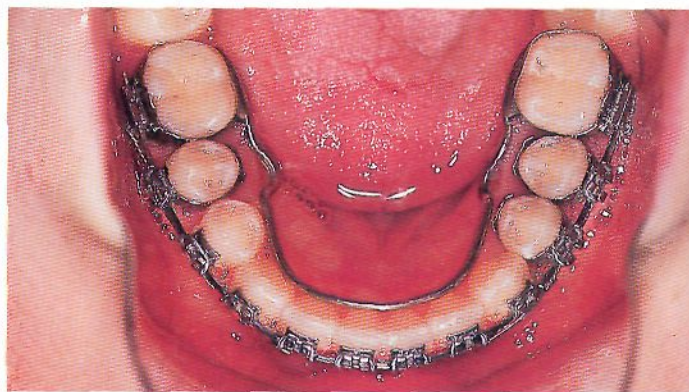


Fig. 7.104

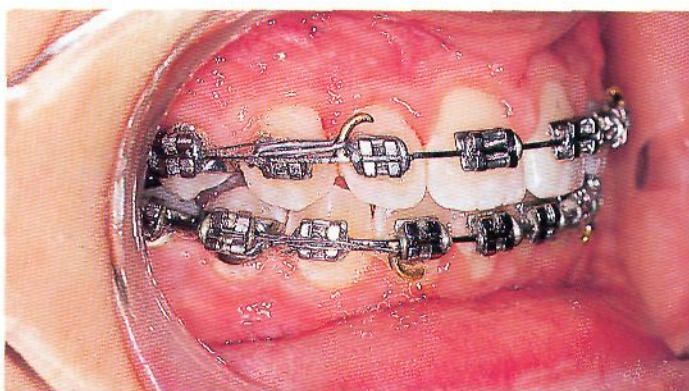


Fig. 7.107

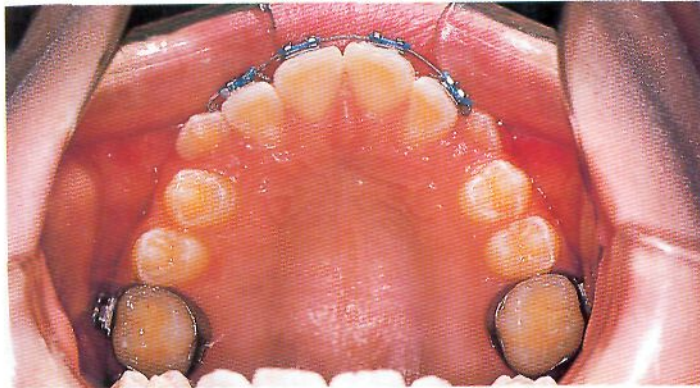


Fig. 7.99

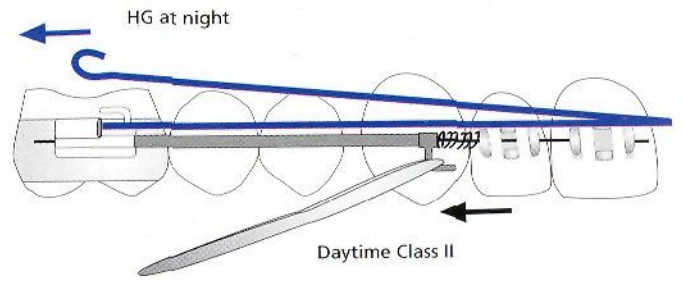


Fig. 7.100

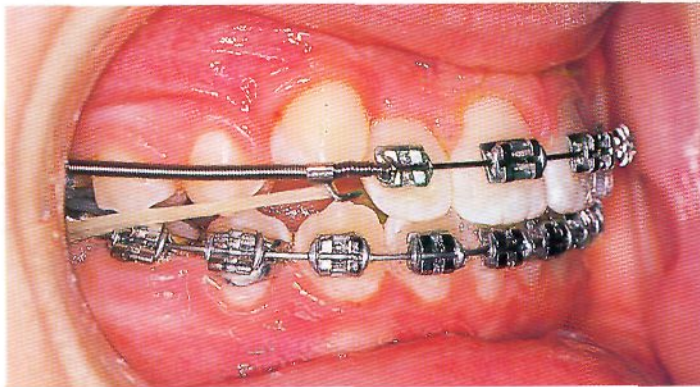


Fig. 7.102

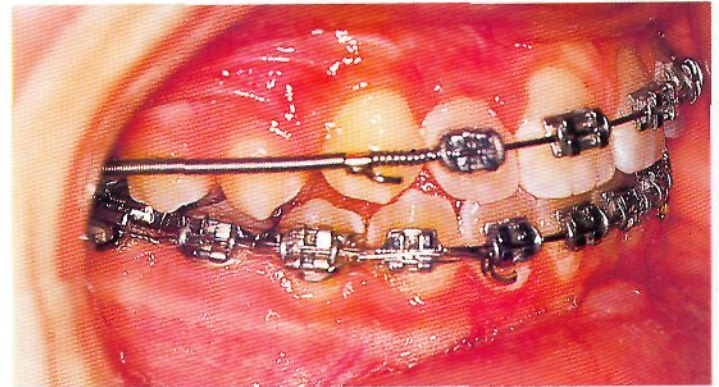


Fig. 7.103

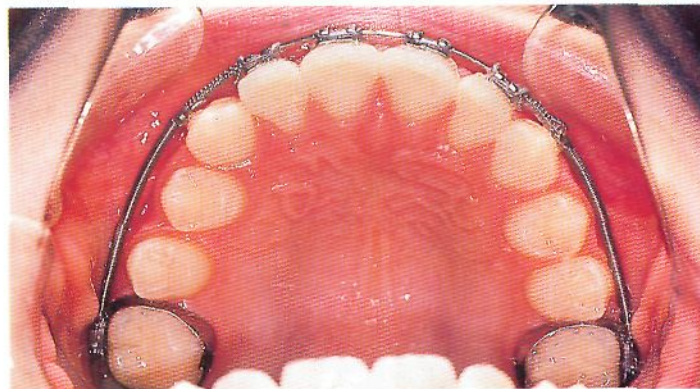


Fig. 7.105

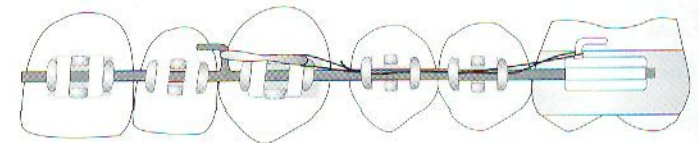


Fig. 7.106



Fig. 7.108

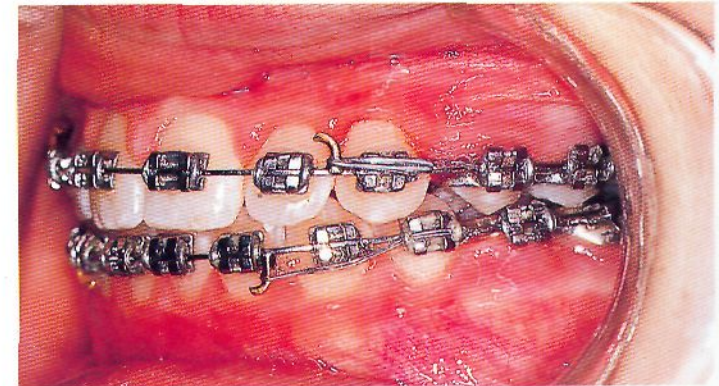


Fig. 7.109

The case after appliance removal.



Fig. 7.110

Occlusal views of the case after treatment. Subsequent development of third molars was monitored.

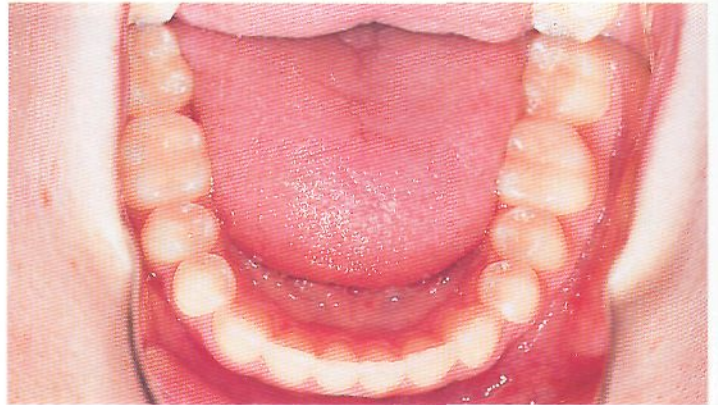


Fig. 7.113

Facial esthetics showed pleasing balance and harmony at the end of treatment, with upper and lower incisors well positioned in the facial complex.

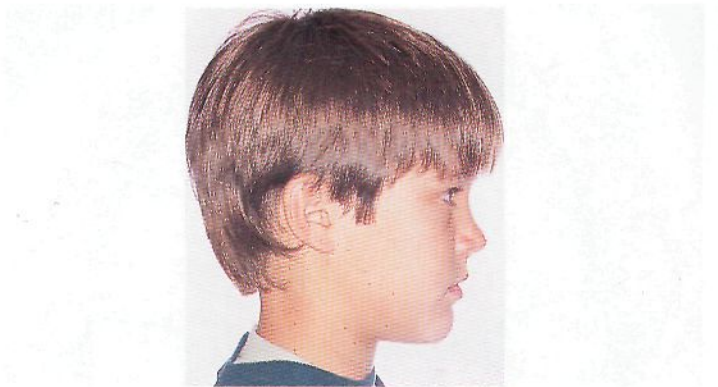


Fig. 7.116



Fig. 7.111

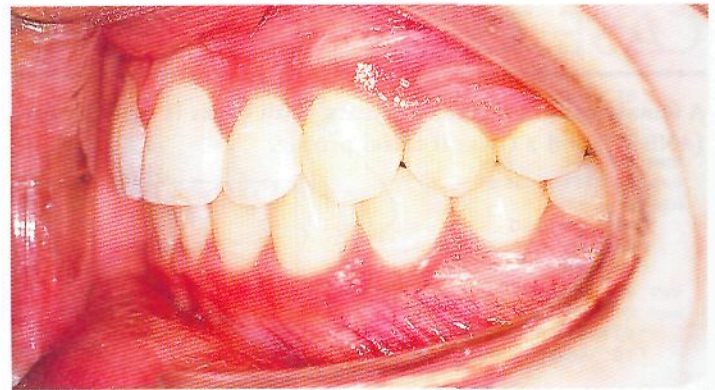


Fig. 7.112

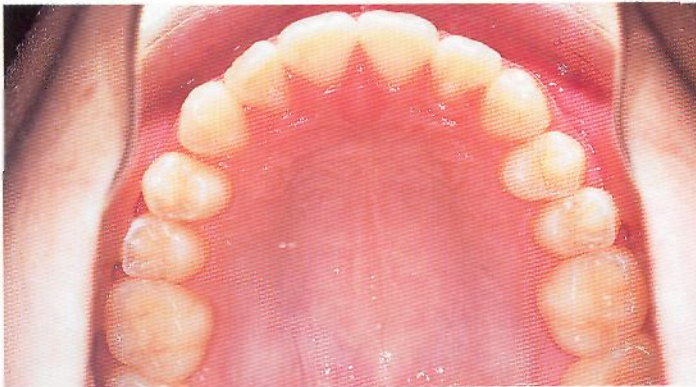


Fig. 7.114

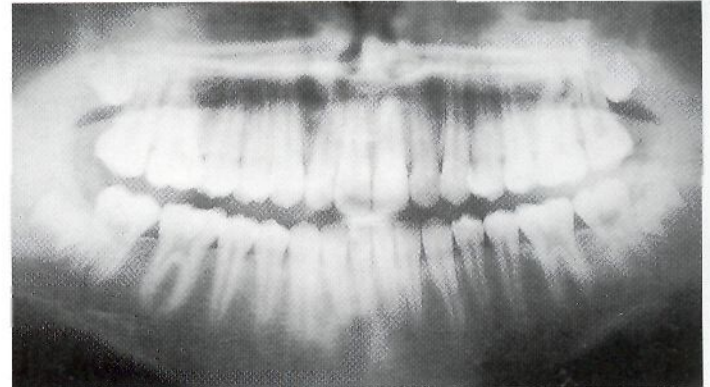


Fig. 7.115

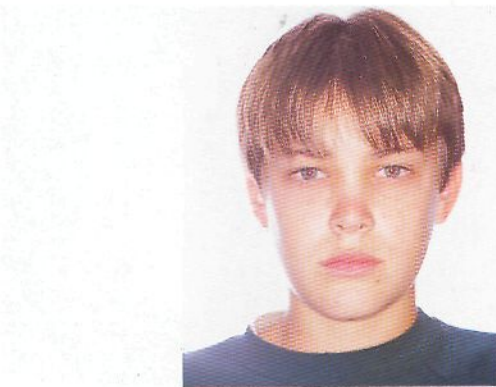


Fig. 7.117

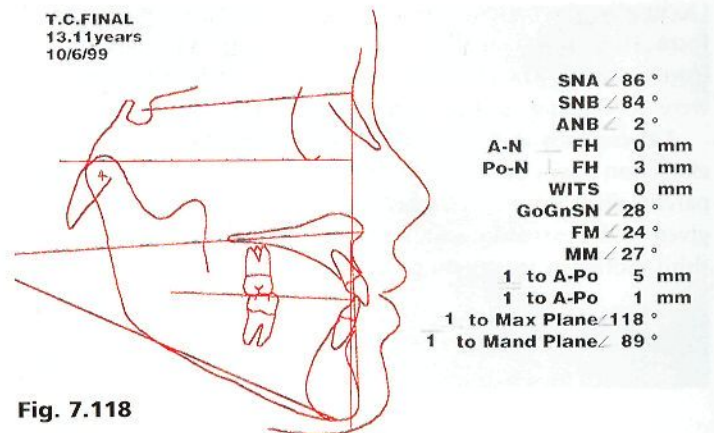


Fig. 7.118

CASE TS

A female patient, aged 14.0 years, with Class II dental bases (ANB 7°) and a Class II facial profile.



Fig. 7.119

Dentally, the patient showed a typical Class II division 1 malocclusion, with slightly retroclined lower incisors, and an increased overjet. Molar relationship was a full unit Class II on the right side and half a unit Class II on the left side.

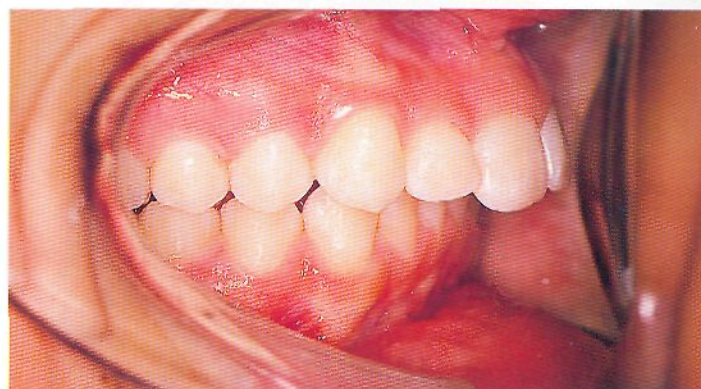


Fig. 7.122

Occlusally, the patient was assessed as having an ovoid arch form. There was a small amount of crowding amongst the lower incisors. The radiographs confirmed that third molars were developing, and were of good size and position.

A decision was made to commence correction on a non-extraction basis, using a twin block appliance. The patient and parents were informed that consideration might need to be given to the extraction of upper second molars and lower third molars as treatment progressed.

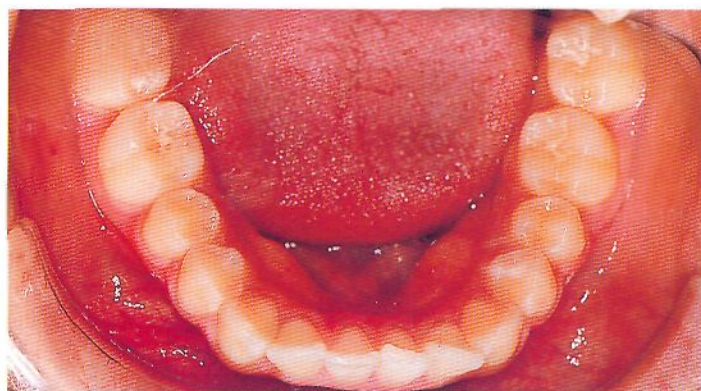


Fig. 7.125

At the start of treatment, upper and lower twin block* appliances were placed for full-time wear.

REFERENCE

*Clark W J 1988 The twin block technique: a functional orthopedic appliance system. American Journal of Orthodontics 93:1-18.

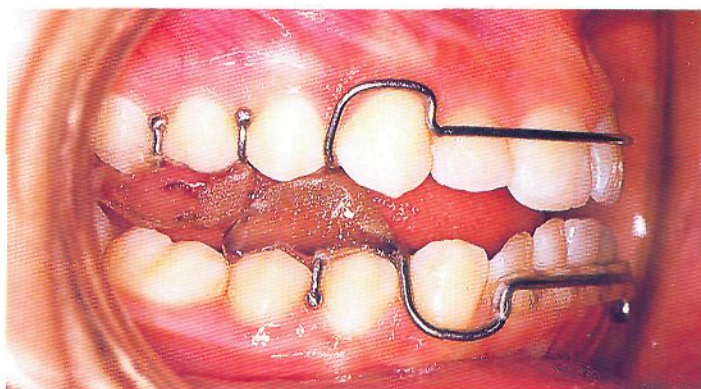


Fig. 7.128



Fig. 7.120

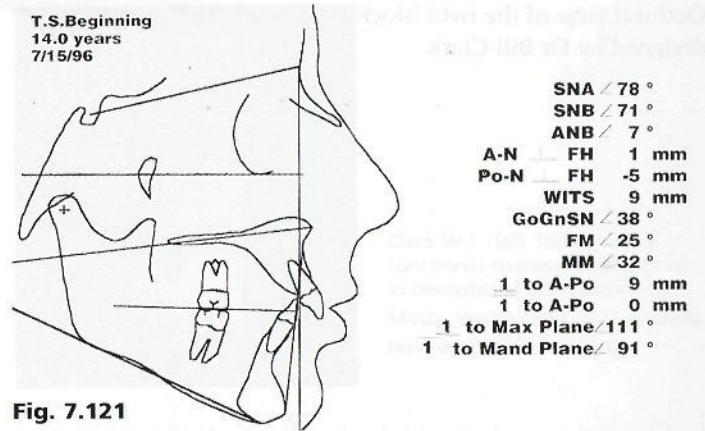


Fig. 7.121



Fig. 7.123

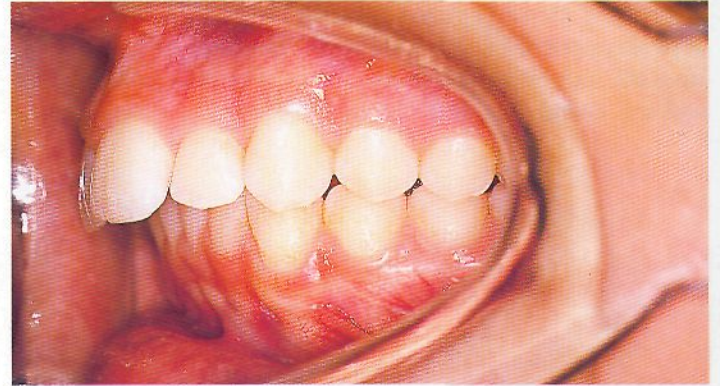


Fig. 7.124

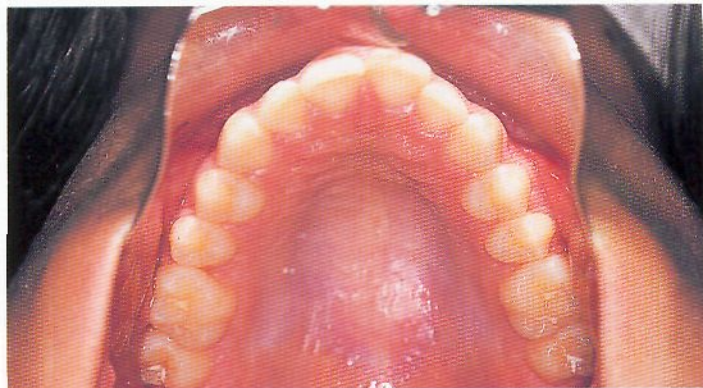


Fig. 7.126

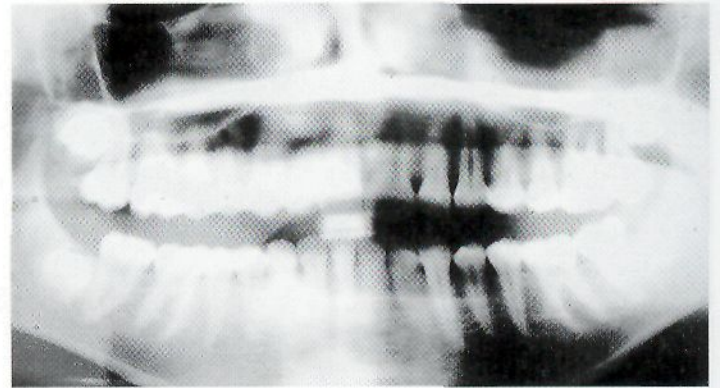


Fig. 7.127

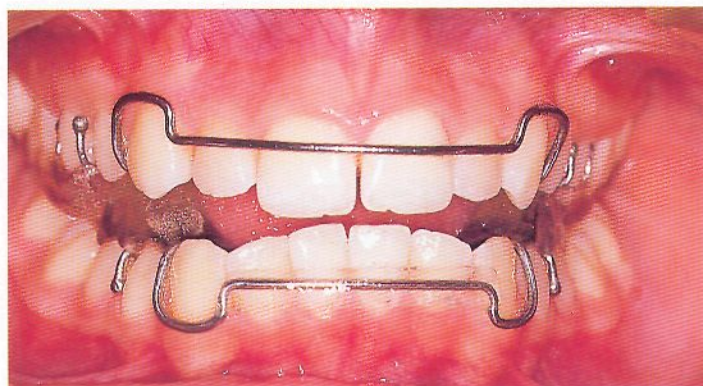


Fig. 7.129

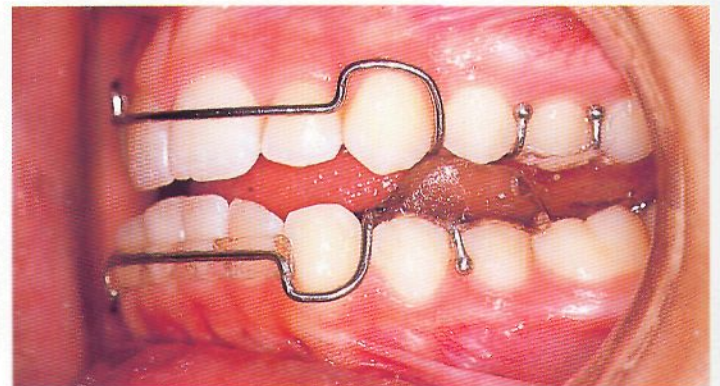


Fig. 7.130

Occlusal view of the twin block appliances. These were designed by Dr Bill Clark.

The patient showed good cooperation with the twin block appliances and these views show the dentition 16 months from the start of treatment. The overjet was fully reduced, and a typical lateral open bite had developed.



Fig. 7.131



Fig. 7.134

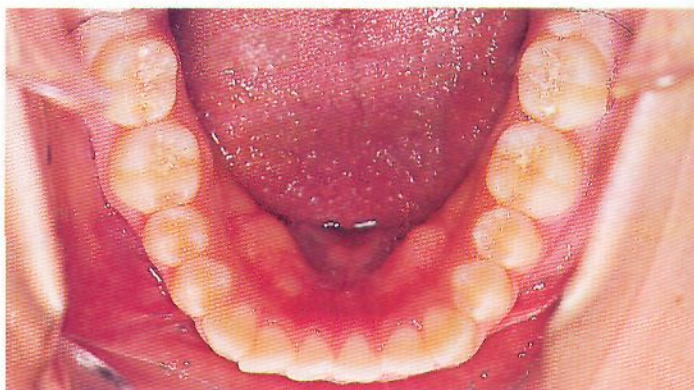


Fig. 7.137

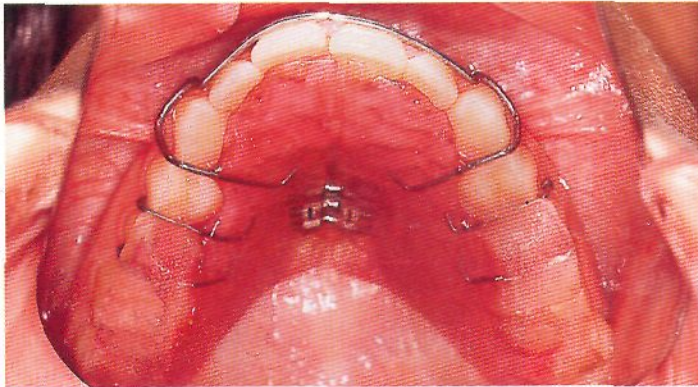


Fig. 7.132

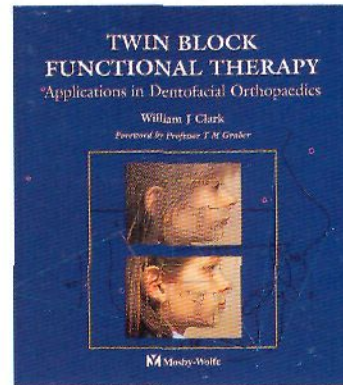


Fig. 7.133

Clark W J 1995 Twin block functional therapy: applications in dentofacial orthopaedics. Mosby Wolfe (ISBN 0723 42120X). New edition due in 2002.



Fig. 7.135

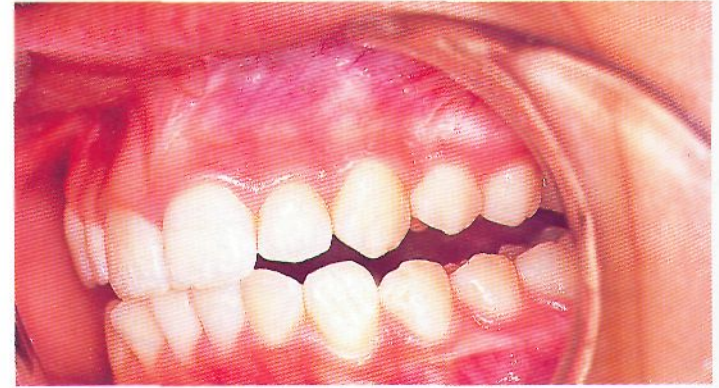


Fig. 7.136

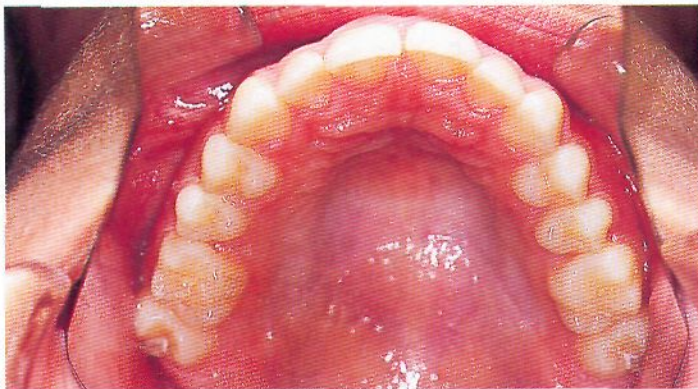


Fig. 7.138

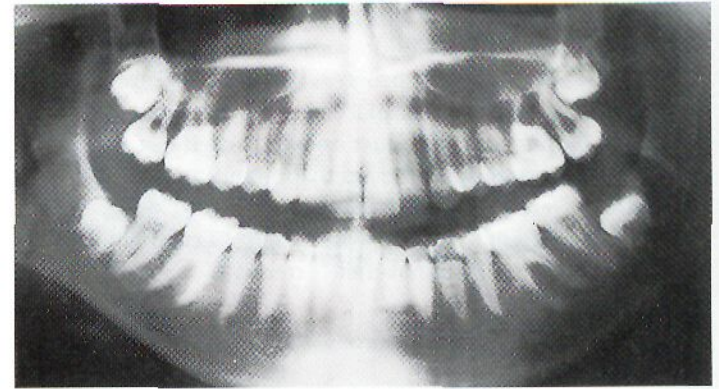


Fig. 7.139

Facial photographs after 16 months of treatment, together with progress tracings.



Fig. 7.140

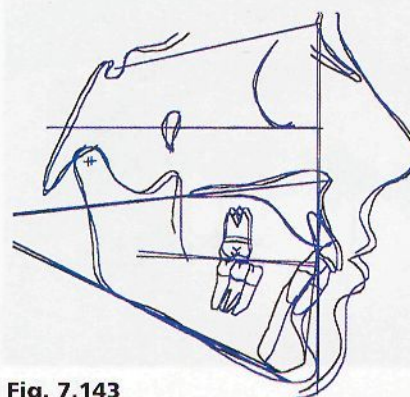


Fig. 7.143

After 16 months, the twin block appliances were discontinued, and upper and lower fixed appliances were placed. Here, the right side progress is shown 1 month, 3 months, and 8 months after placement of the fixed appliances. Some enamel reduction was carried out among the lower incisors early in the fixed appliance phase. .016 HANT wires were followed by rectangular HANT wires and then steel rectangular working wires. Light Class II elastics were used to maintain the overjet correction.



Fig. 7.146

Fixed appliances were in place for a total of 12 months. Here, the case is seen 10 months into fixed appliances, during the typical settling phase.



Fig. 7.149



Fig. 7.141

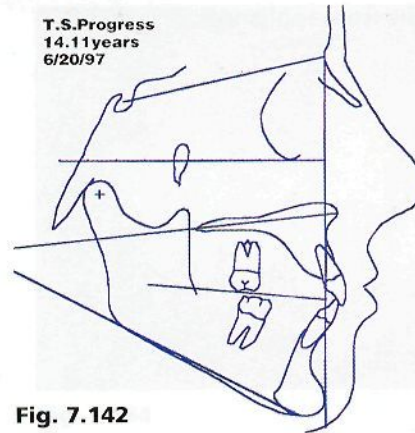
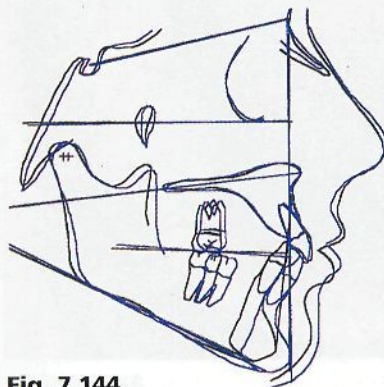


Fig. 7.142

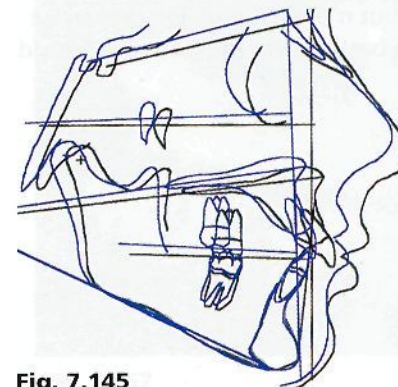
SNA	78°
SNB	74°
ANB	4°
A-N	FH 0 mm
Po-N	FH 0 mm
WITS	2 mm
GoGnSN	40°
FM	27°
MM	33°
1 to A-Po	6 mm
1 to A-Po	4 mm
1 to Max Plane	106°
1 to Mand Plane	98°



**Palatal Plane &
Palate Curvature**

**T.S.Begin
T.S.Progress**

Fig. 7.144



**Mand. Symphysis
& Mand. Plane**

**T.S.Begin
T.S.Progress**

Fig. 7.145

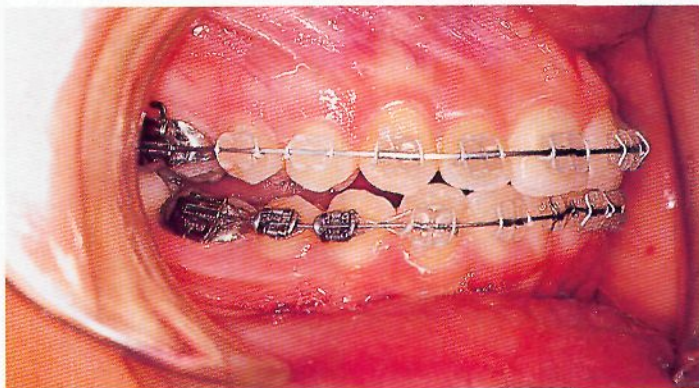


Fig. 7.147

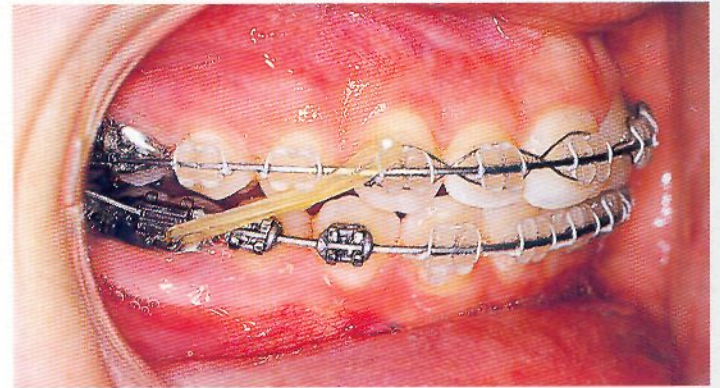


Fig. 7.148



Fig. 7.150

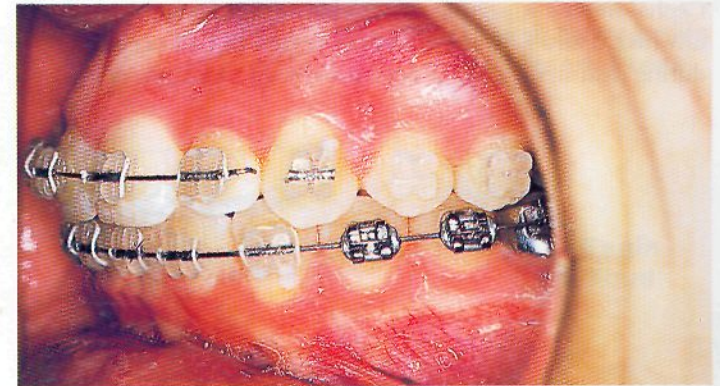


Fig. 7.151

The case after removal of the fixed appliances.



Fig. 7.152

Good progress had been made. Extractions were discussed during treatment planning, but it proved possible to manage the case on a non-extraction basis. It was finished to an ovoid arch form.

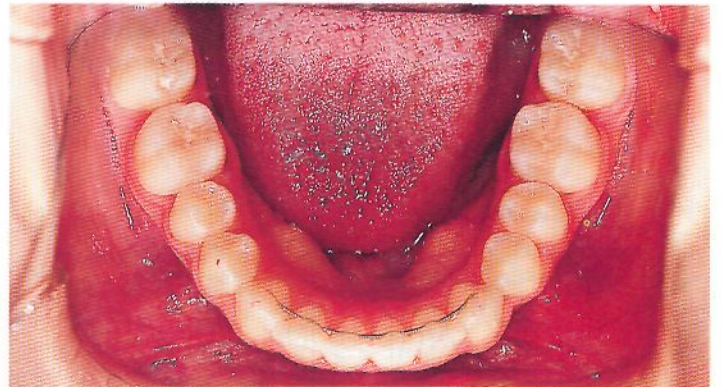


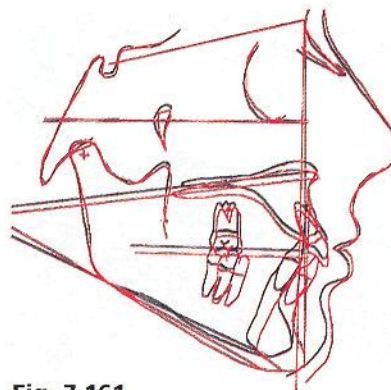
Fig. 7.155

A pleasing improvement in facial esthetics was achieved, and Figure 7.158 compares before and after profiles. The ANB angle changed from 7° to 3° during the treatment period (Fig. 7.2, p. 164).



Fig. 7.158

Cephalometric superimpositions show that favorable downward and forward mandibular growth had occurred during treatment, mainly during the twin block phase.



SN at S

**T.S.Begin
T.S.Final**

Fig. 7.161



Fig. 7.153



Fig. 7.154

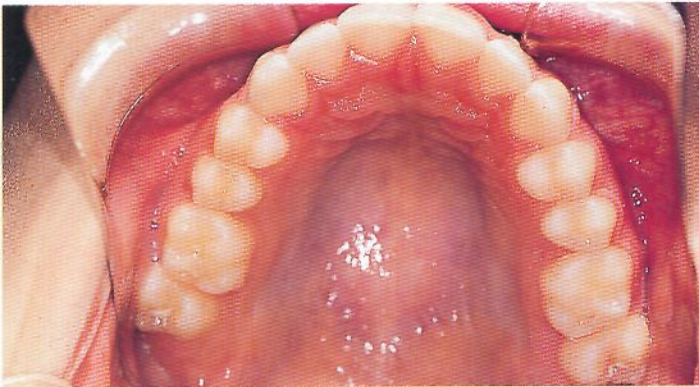


Fig. 7.156

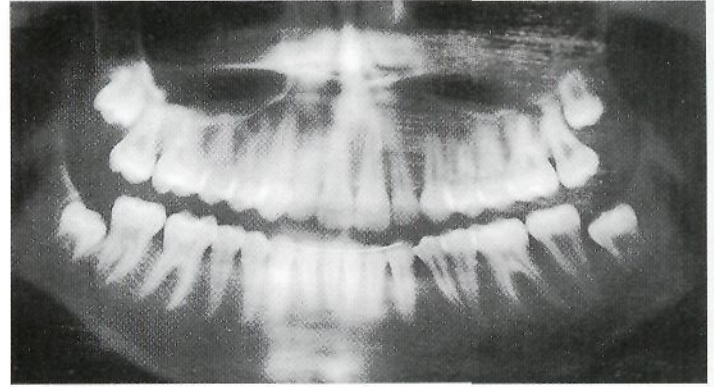


Fig. 7.157



Fig. 7.159

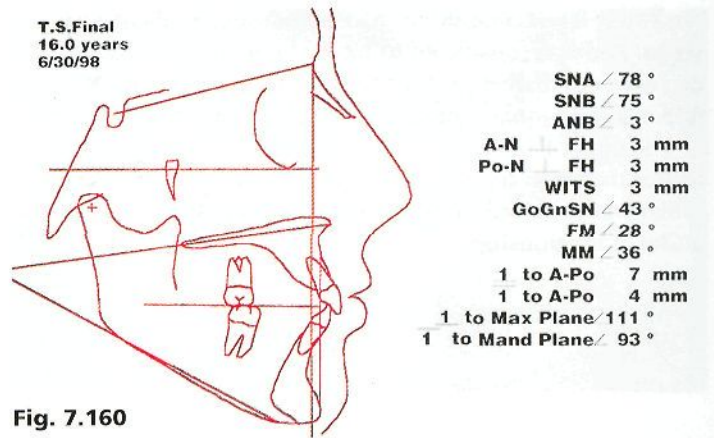
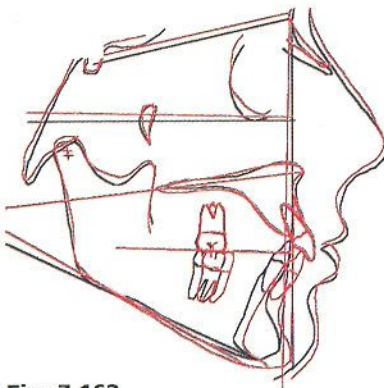


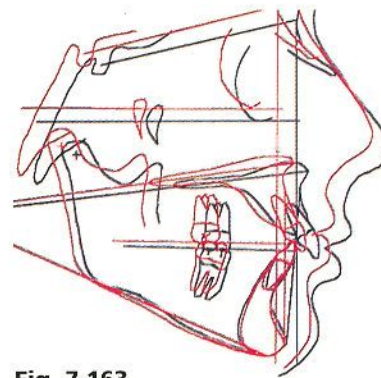
Fig. 7.160



Palatal Plane &
Palate Curvature

T.S.Begin
T.S.Final

Fig. 7.162



Mand. Symphysis
& Mand. Plane

T.S.Begin
T.S.Final

Fig. 7.163

CASE DO

An adult female patient, aged 19.11 years, with Class I dental bases (ANB 3°) and a slightly low-angle pattern (MM 23°). Upper incisors were retroclined at 97° to the maxillary plane, and lower incisors were retroclined at 84° to the mandibular plane.

The patient presented with a typical Class II division 2 malocclusion. The molar relationship was 1 mm Class II on the left and 5 mm Class II on the right side. There was an associated midline discrepancy of 3 mm.

The lower left second molar had been a source of chronic sepsis, and was considered to have a very poor prognosis. A decision was made to extract this tooth, together with the upper second molars and the lower right third molar.

The upper left second molar was extracted to balance the loss of the lower left second molar. The upper right second molar was extracted to assist treatment mechanics, to achieve a Class I relationship.



Fig. 7.164

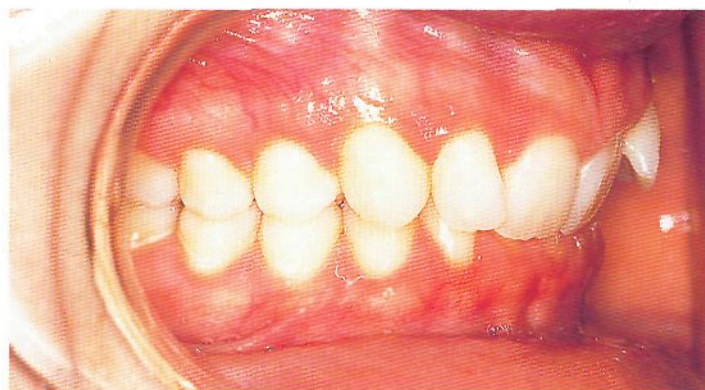


Fig. 7.167



Fig. 7.170



Fig. 7.165

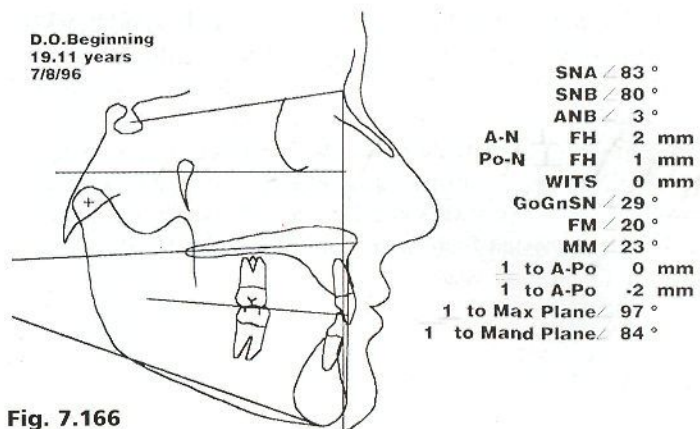


Fig. 7.166



Fig. 7.168

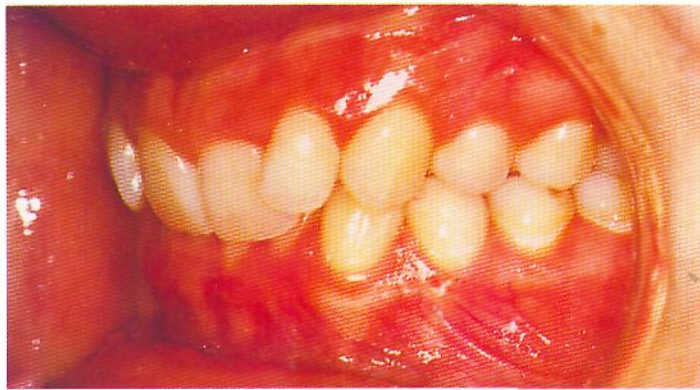


Fig. 7.169

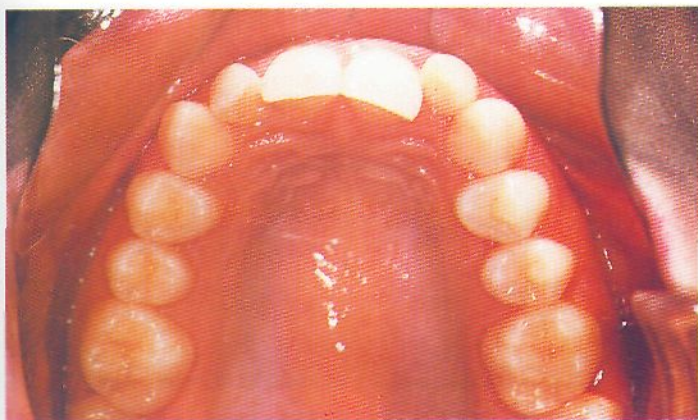


Fig. 7.171

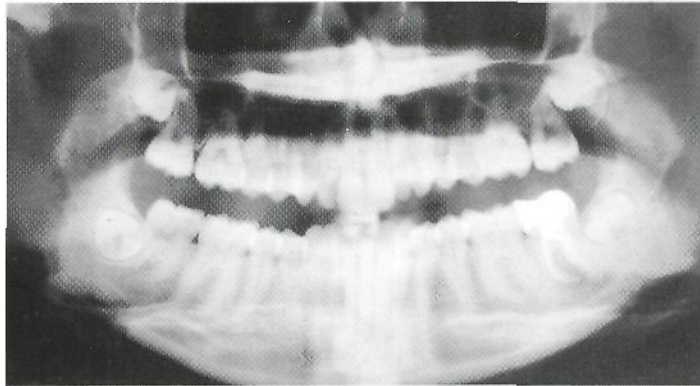


Fig. 7.172

At the start of treatment, all molars were banded and brackets were bonded on the remaining teeth. Additionally, an upper acrylic removable bite plate was provided for full-time wear. The opening upper arch wire was .0175 multistrand, with a bend in the upper left central incisor region to reduce force. This was replaced 1 month later by a .016 HANT wire. During the first 2 months, a .016 HANT wire was used in the lower arch. The lower left first molar band was repositioned at the second adjustment visit.

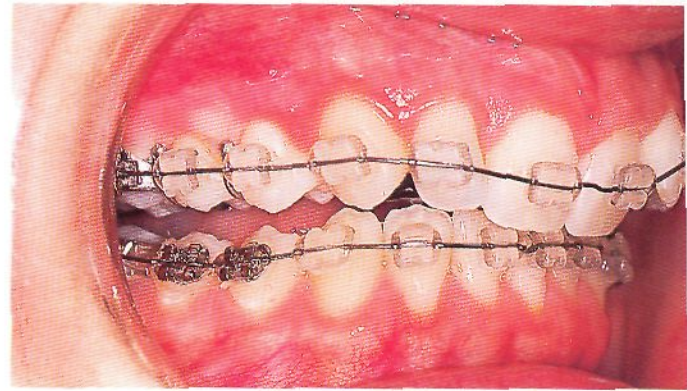


Fig. 7.173

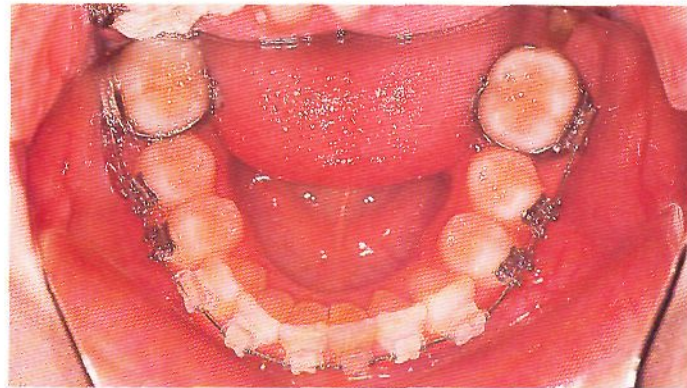


Fig. 7.176

Sequential views of the right side occlusion 2 months, 3 months, and 7 months into treatment. At 2 months, upper and lower rectangular HANT wires were placed, and the bite plate was discontinued. After 7 months, upper and lower rectangular steel wires were placed to complete correction of the overbite (p. 111).

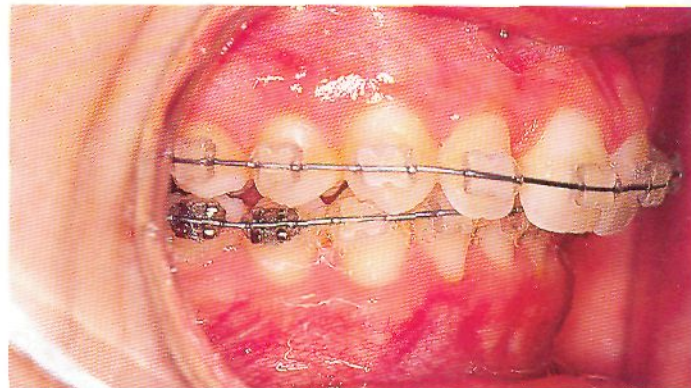


Fig. 7.179

Occlusal views of the case after 8 months of treatment. The patient was asked to wear full-time light Class II elastics to assist bite opening.



Fig. 7.182



Fig. 7.174

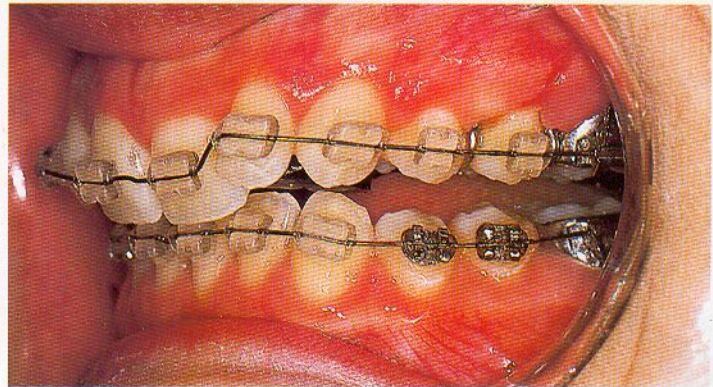


Fig. 7.175

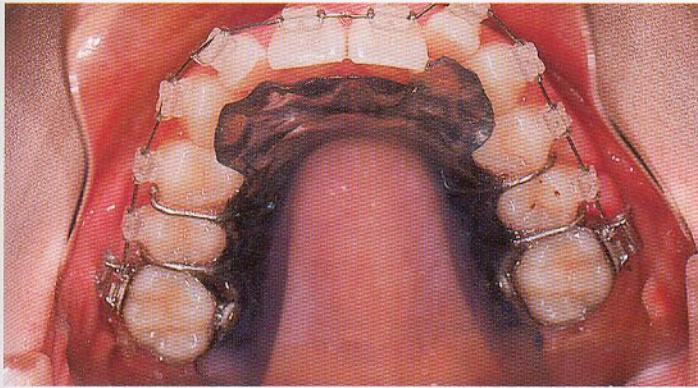


Fig. 7.177

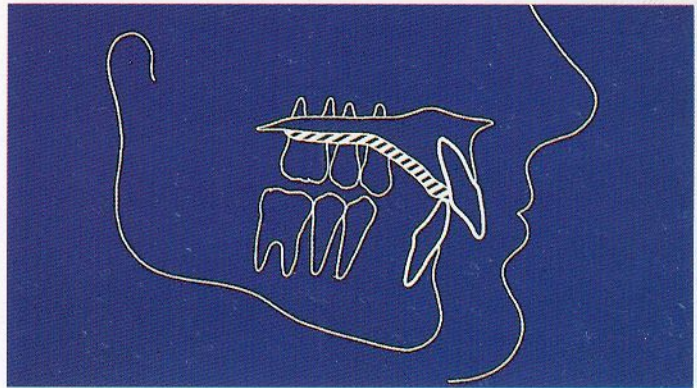


Fig. 7.178

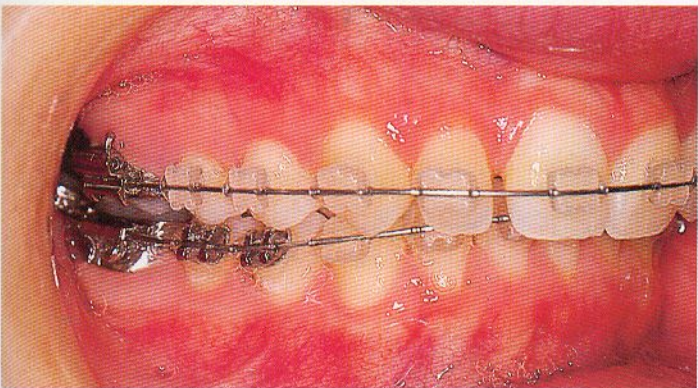


Fig. 7.180

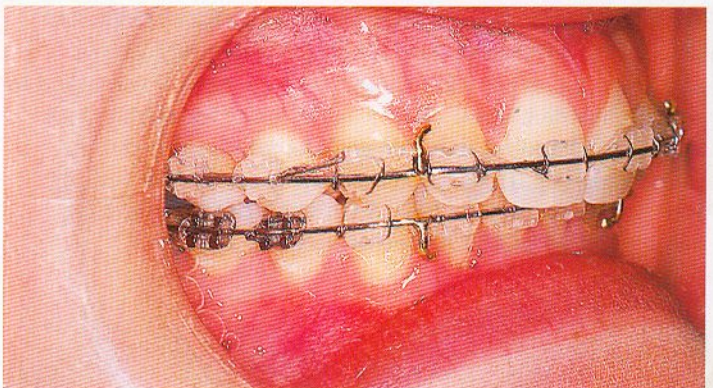


Fig. 7.181

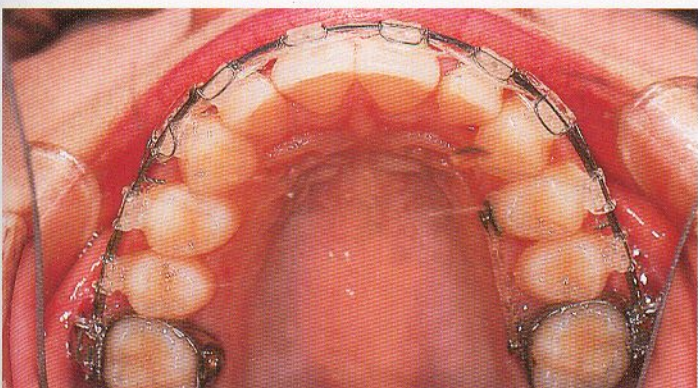


Fig. 7.183

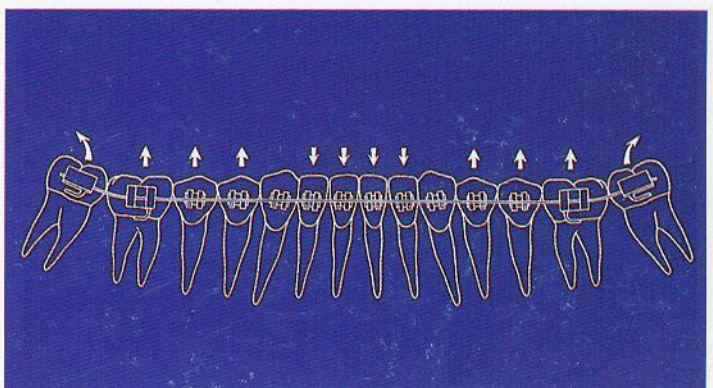


Fig. 7.184

Reverse curves (p. 137) were added to the rectangular wires after they had been in place for 2 months. Addition torque was placed in the upper incisor region to assist bite opening.

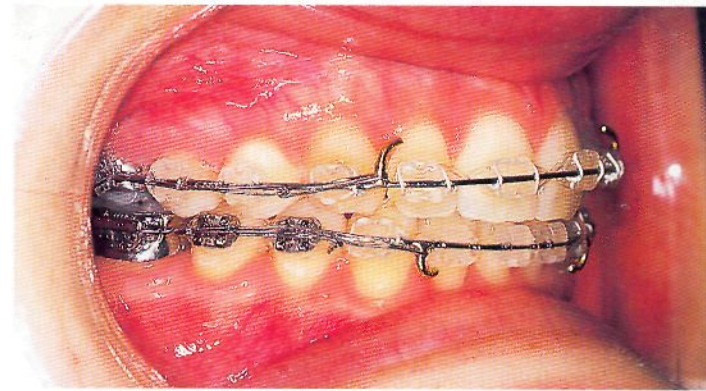


Fig. 7.185

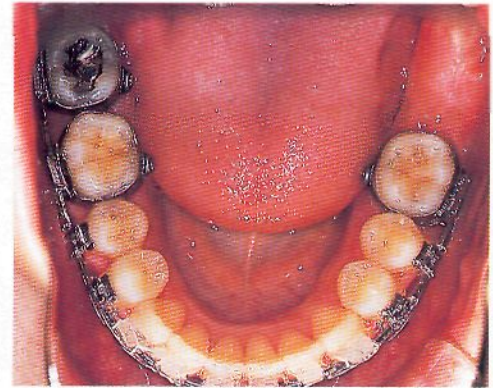


Fig. 7.188

Settling was commenced after 14 months of treatment, and .016 HANT wires were used for this. A Kobayashi tie was placed on the upper right canine, and the patient was asked to wear right side Class II elastics as necessary to maintain the buccal occlusion on that side and the midline correction.

A full upper .014 or .016 archwire is used when settling some Class II cases (p. 295). Such wires can be bent back behind molars to control the overjet.

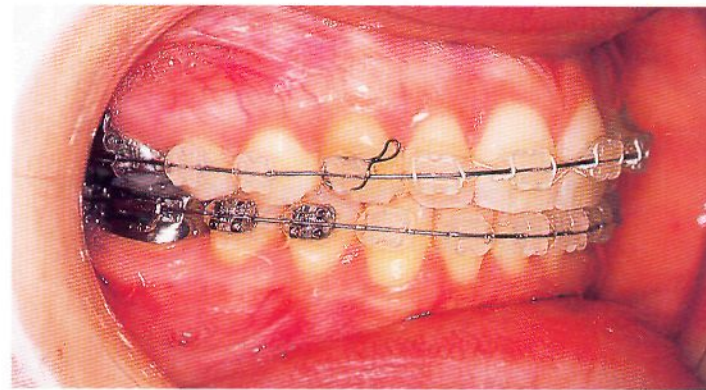


Fig. 7.191

The case after removal of fixed appliances and 1 month of further settling.



Fig. 7.194



Fig. 7.186

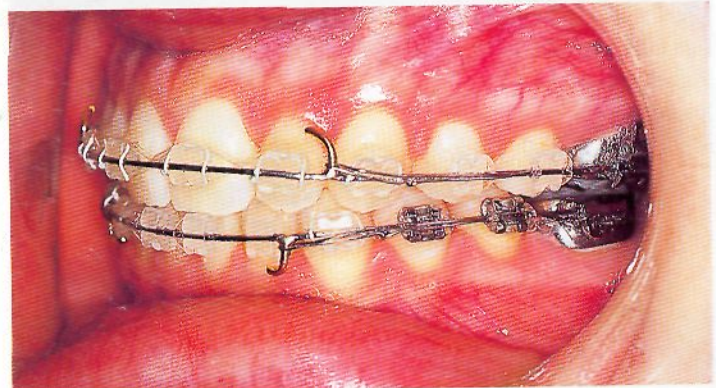


Fig. 7.187

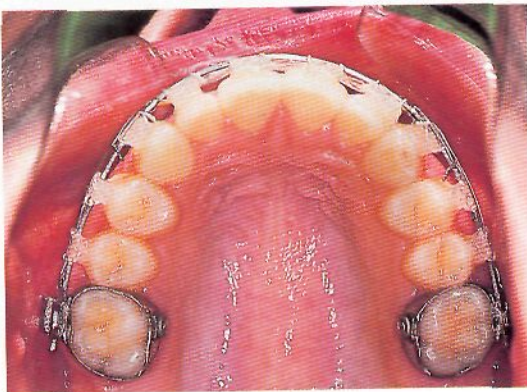


Fig. 7.189

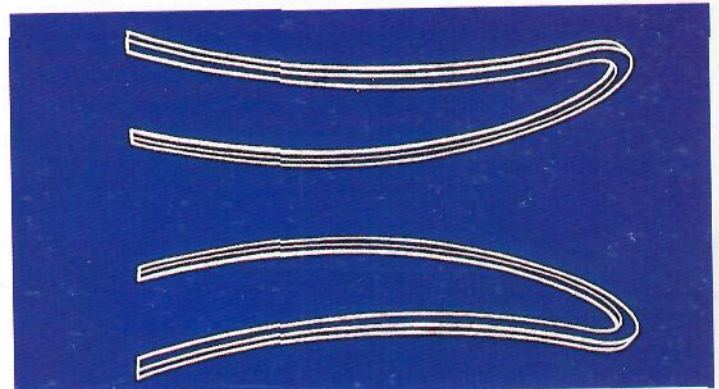


Fig. 7.190

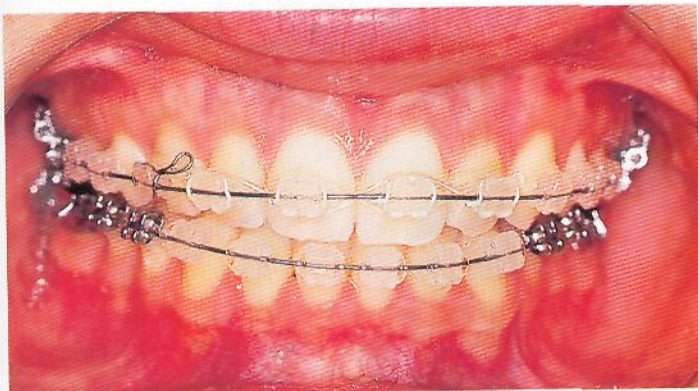


Fig. 7.192

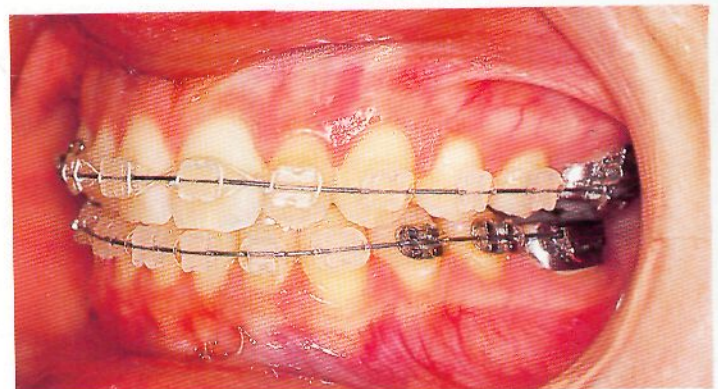


Fig. 7.193



Fig. 7.195



Fig. 7.196

Occlusal views of the case after band removal and 1 month of settling. It was agreed with the patient to monitor the development and eruption of the three remaining third molars.

A subtle but pleasing improvement in the facial profile occurred as a result of upper and lower incisors being moved to more appropriate positions in the facial complex. During treatment the SNA angle increased from 83° to 84° (p. 170). SNB angle increased by 2° to 82° (p. 181).

www.allislam.net
Problem

Superimpositions confirm that most of the correction was obtained by dental change, although there was some mesial movement of pogonion during the treatment period.

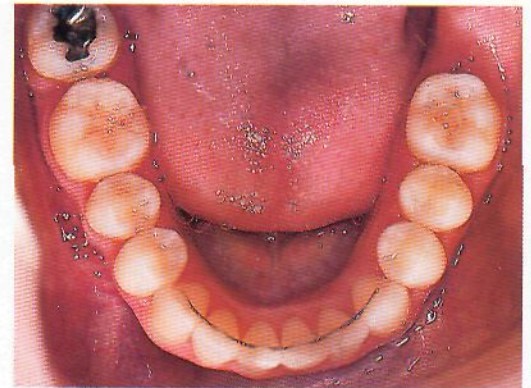


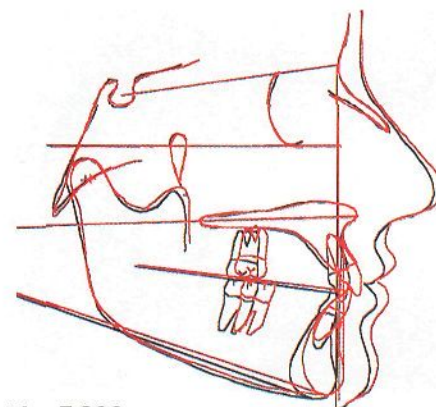
Fig. 7.197



Fig. 7.200



Fig. 7.203



SN at S

D.O. Begin
D.O. Final

Fig. 7.206

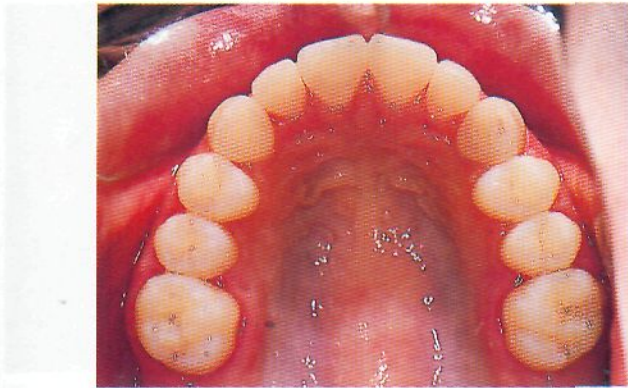


Fig. 7.198

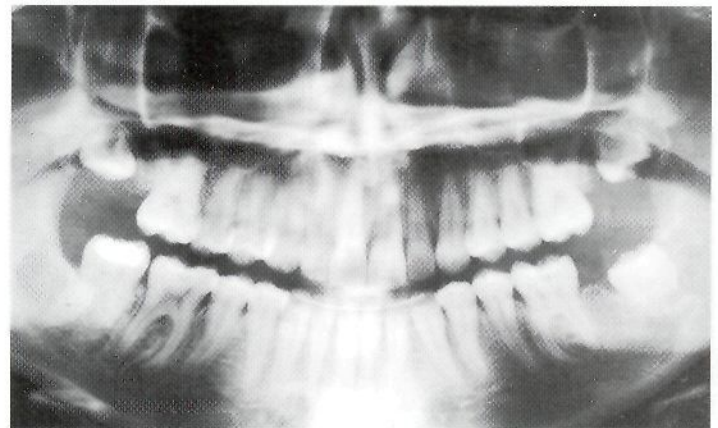


Fig. 7.199



Fig. 7.201

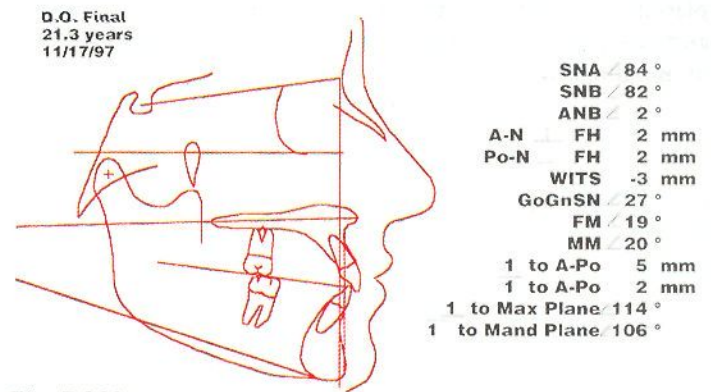


Fig. 7.202



Fig. 7.204



Fig. 7.205

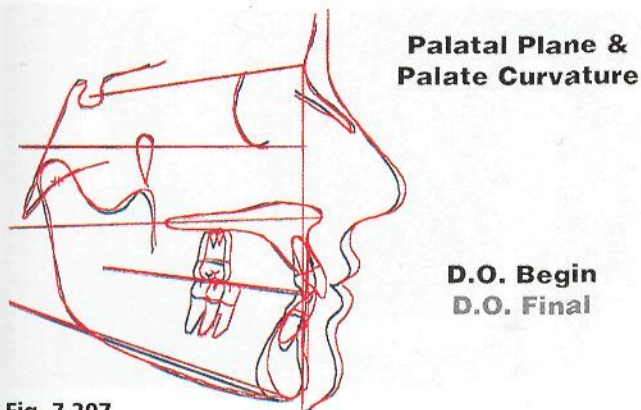


Fig. 7.207

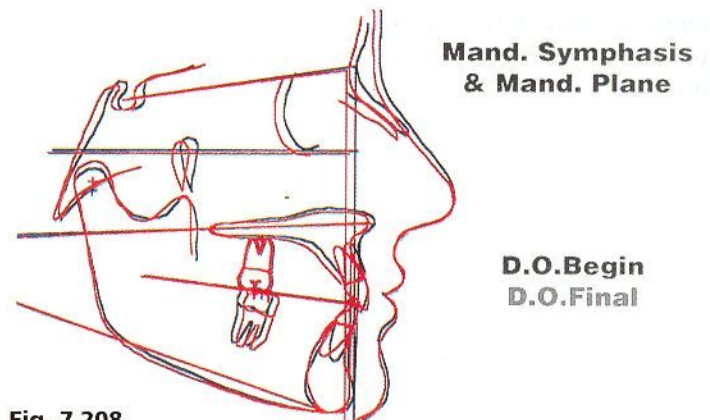


Fig. 7.208

Intraoral photographs taken 19 months after completion of treatment show that the lower left third molar has erupted into a less than ideal position.

A lower lingual arch from first molar to first molar was placed, with a band on the lower left third molar. A section archwire was used together with a separating module to assist in uprighting the lower left third molar.

Intraoral photographs after correction of the lower left third molar.

Occlusal views of the case after completion of the orthodontic treatment. Upper third molars erupted into satisfactory position (p. 173).



Fig. 7.209

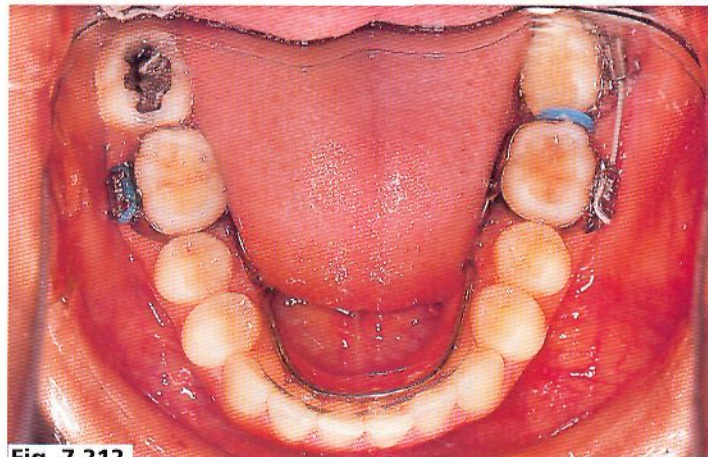


Fig. 7.212



Fig. 7.215

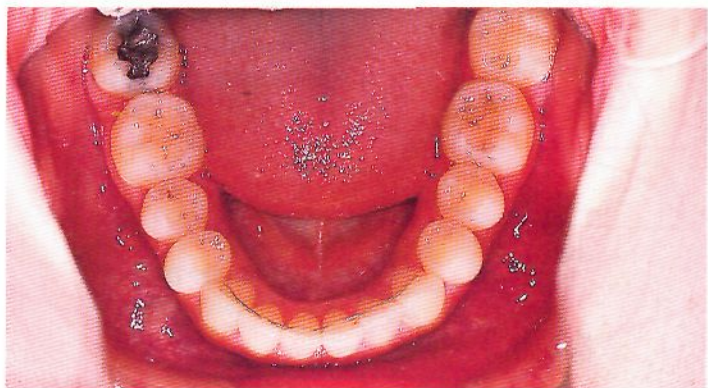


Fig. 7.218



Fig. 7.210

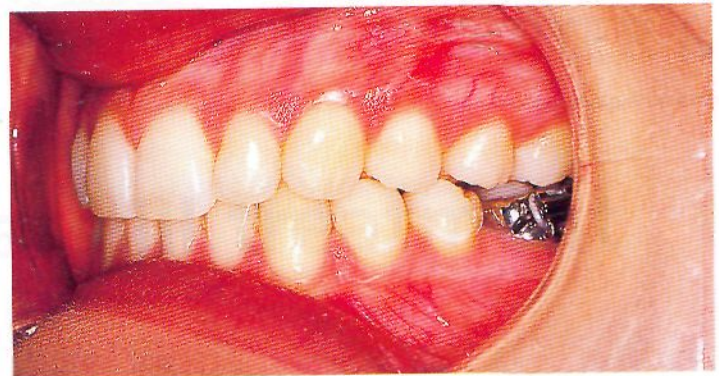


Fig. 7.211

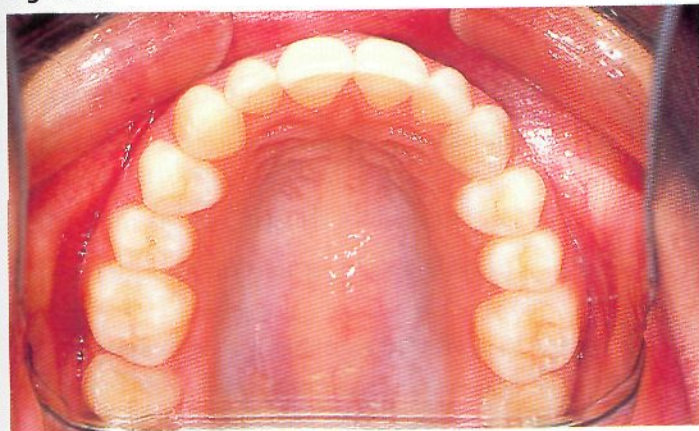


Fig. 7.213

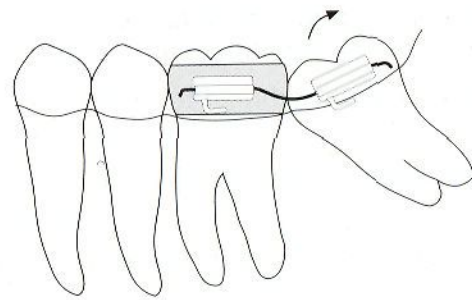


Fig. 7.214



Fig. 7.216

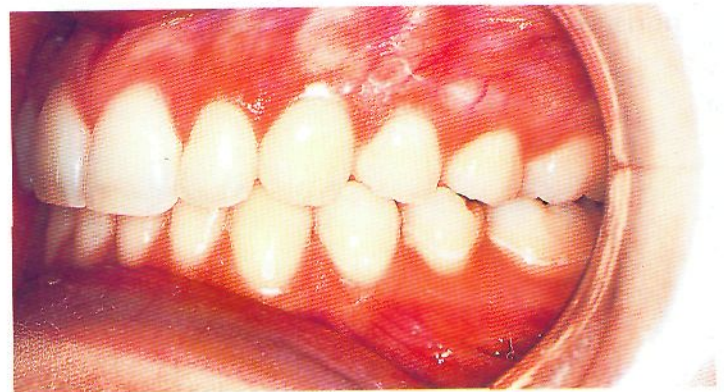


Fig. 7.217

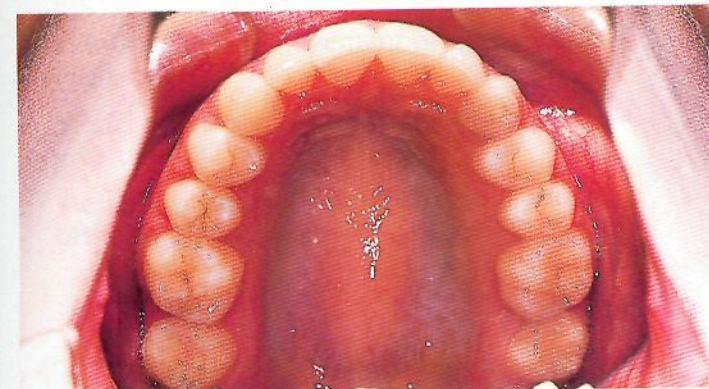


Fig. 7.219

CHAPTER 8

An overview of Class III treatment

Introduction 219

Accurate record-taking – displacements 219

Mandibular prognathism or maxillary retrognathism? 220

The timing of Class III treatment 220

The surgical/non-surgical decision in Class III treatment 222

The posterior 'squeezing out' effect of molar crowding 224

Class III mechanics 225

The four-stage treatment planning process 226

Setting a PIP for the upper incisors 226

The lower incisors 226

The remaining upper teeth 227

The remaining lower teeth 227

PIP components in Class III treatment 228

Upper incisor movement in Class III treatment 229

Mesial movement of upper incisors within the bone 230

Limits to mesial movement of upper incisors 230

Mesial movement of maxillary bone due to growth 231

Mesial movement of maxillary bone due to orthodontic treatment 231

Lower incisor movement in Class III cases 232

Distal movement and retraction of the lower incisors within the mandibular bone 232

Distal movement of mandibular bone – distal repositioning 233

Distal movement of mandibular bone – restriction of growth? 233

Mesial movement of mandibular bone – Class III growth 234

Case MS A Class III non-extraction case with crowding 236

Case KB A Class III case treated with extraction of second molars 242

INTRODUCTION

The introductory discussion in Chapter 7 (p. 162) concerning 'tooth alignment' orthodontics versus 'denture positioning' orthodontics is relevant to Class III treatment. The majority of Class III orthodontic cases require denture positioning procedures to achieve and then maintain a correct incisor relationship in the facial complex. It is beyond the scope of this text to discuss details of the Class III planning process, but the following general comments and overview will emphasize key points which can be related to treatment mechanics.

Successful treatment of Class III cases depends on identifying the true nature of the malocclusion, and on evaluating any probable growth changes. The following are relevant to the management of these cases:

- Accurate record-taking – displacements
- Mandibular prognathism or maxillary retrognathism?
- The timing of Class III treatment
- Making the correct surgical/non-surgical decision
- The posterior 'squeezing out' effect of molar crowding
- The use of Class III mechanics.

Accurate record-taking – displacements

If there is a mandibular displacement between centric relation (CR) and centric occlusion (CO), this needs to be identified and accurately recorded at the record-taking appointment. Displacements (Fig. 8.1) can be a major factor in determining a surgical versus non-surgical decision for some patients.

It is therefore essential to take records with the condyles centered in the fossae, so that treatment planning can be based on the CR position of the mandible. This will involve placing a wax bite (Fig. 8.2) for the record-taking process, including study models, facial photos, cephalometric radiographs, and, for some cases, tomographic radiographs. It is then necessary to adjust for the slight mandibular opening during facial and cephalometric analysis. The true A/P position of the mandible, with centered condyles, needs to be accurately established in this way, as a basis for treatment planning.

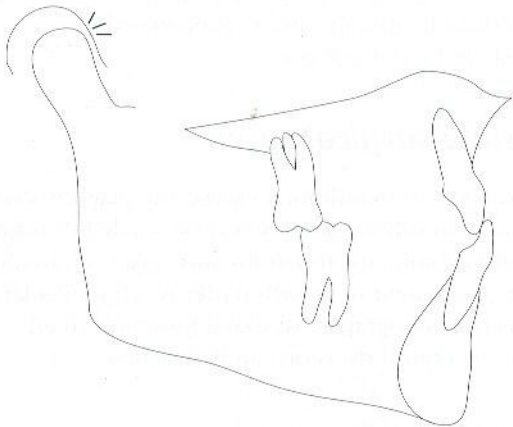


Fig. 8.1 Mandibular displacements are frequently found in Class III malocclusions. They need to be identified and accurately recorded.

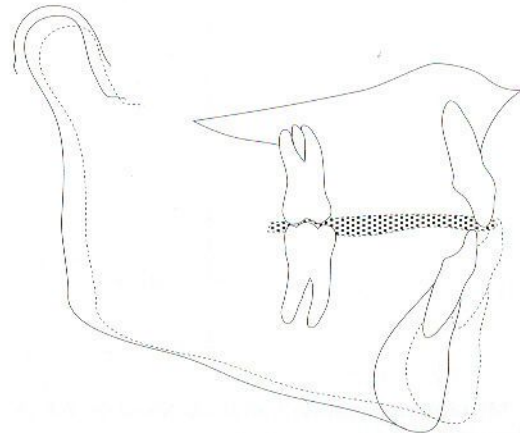


Fig. 8.2 A waxbite is required to accurately record the A/P position of the mandible, with condyles centered. In this way, accurate treatment planning will be possible, based on records taken with the mandible at the CR position.

Mandibular prognathism or maxillary retrognathism?

Early in Class III treatment planning, it is necessary to decide whether the case has a prognathic mandible or a retrognathic maxilla, or a combination of these two possibilities. In many cases, this will be clear from visual examination of the patient and the radiographs.

There are several methods of conventional cephalometric analysis to assess A/P skeletal discrepancy. For example, SNA, SNB, and ANB can be compared with Michigan normals¹ for a male or female of the same age. This method has accepted shortcomings, but has been a mainstay indicator of skeletal disproportion for many years. McNamara² suggested dropping a line from nasion perpendicular to Frankfort horizontal to evaluate the position of 'A' point and 'B' point, as a useful indicator of skeletal discrepancy (Fig. 8.3).

The Arnett analysis (p. 163) uses a true vertical line (TVL) as a facial reference and it is recommended (Fig. 8.4) as a more sophisticated and accurate method of deciding the needs of the case (Fig. 8.5).

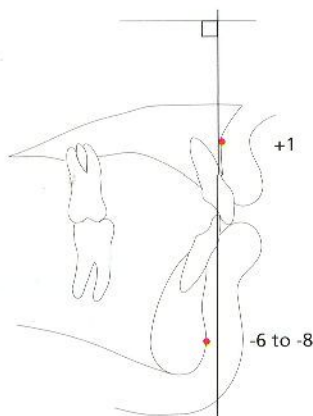


Fig. 8.3 McNamara suggested analysis based on nasion perpendicular.

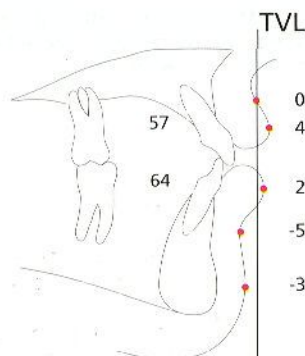


Fig. 8.4 The Arnett analysis uses a true vertical line.

The timing of Class III treatment

Early correction of mandibular displacements

These should be identified at dental age 8 or 9, soon after the adult incisors erupt. This incisor relationship has the potential to restrict maxillary development and encourage mandibular growth, thereby worsening the Class III problem. This is similar to the effect of a functional appliance in Class II treatment.

Normally, such displacements can be corrected by simple tooth movements, and it is important for treatment to be provided at an early age. Subsequently, unrestricted maxillary development can resume, and if the condyles are centered in the fossae, this will eliminate the potential 'functional appliance' effect of the original mandibular displacement.

Maxillary retrognathism

Growing patients who present with maxillary retrognathism should be considered for early expansion and development of the maxilla. This may involve the use of rapid maxillary expansion and a reverse headgear. Subsequently, a palatal bar can be used to stabilize the skeletal change, and then full fixed appliance treatment can be commenced at approximately 12 years of age.

Borderline surgical cases

In some cases with mandibular excess, the diagnosis will suggest that mandibular surgery *may* be needed. It is helpful to delay orthodontic treatment for such cases, if possible. This will allow assessment of growth patterns, using regular cephalometric radiographs, so that a more informed surgical/non-surgical decision can be reached.

Class III surgical cases

Some cases are clearly Class III surgical cases from the outset, and should not be treated until all growth has ceased. Timing will be agreed with the surgeon, and may be beyond the age of 20 years in males and a little earlier in females.

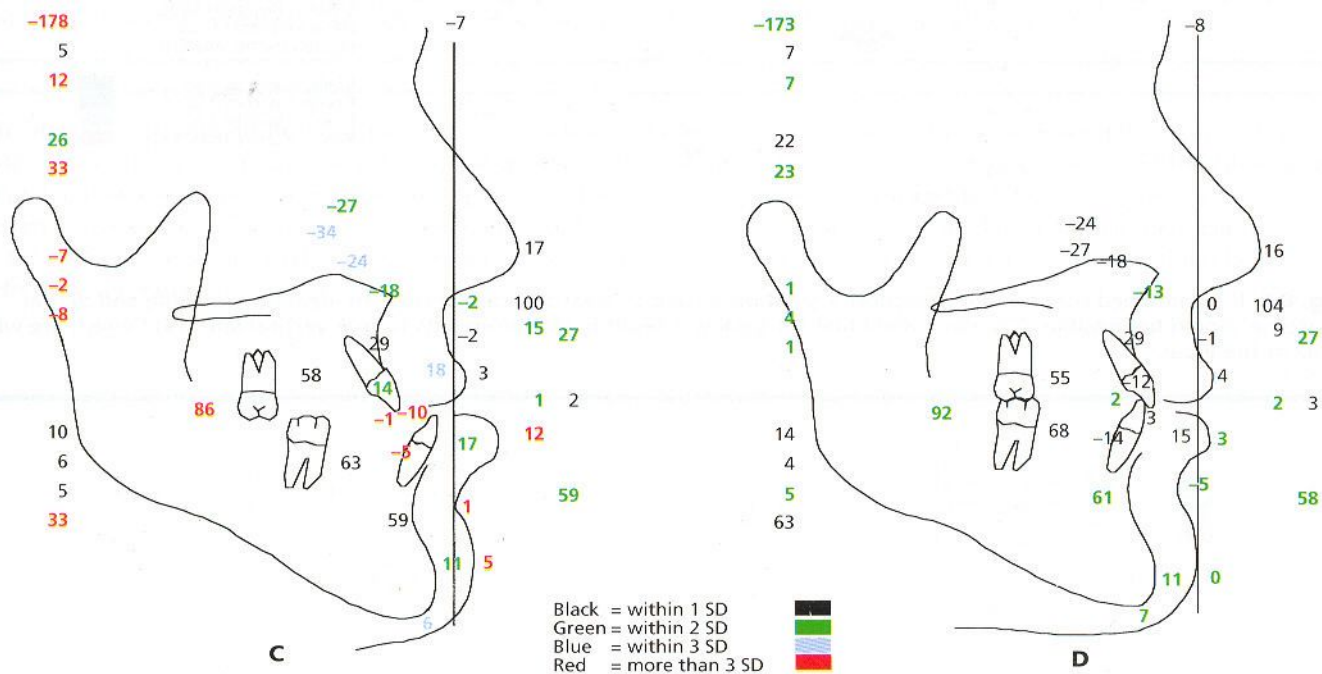
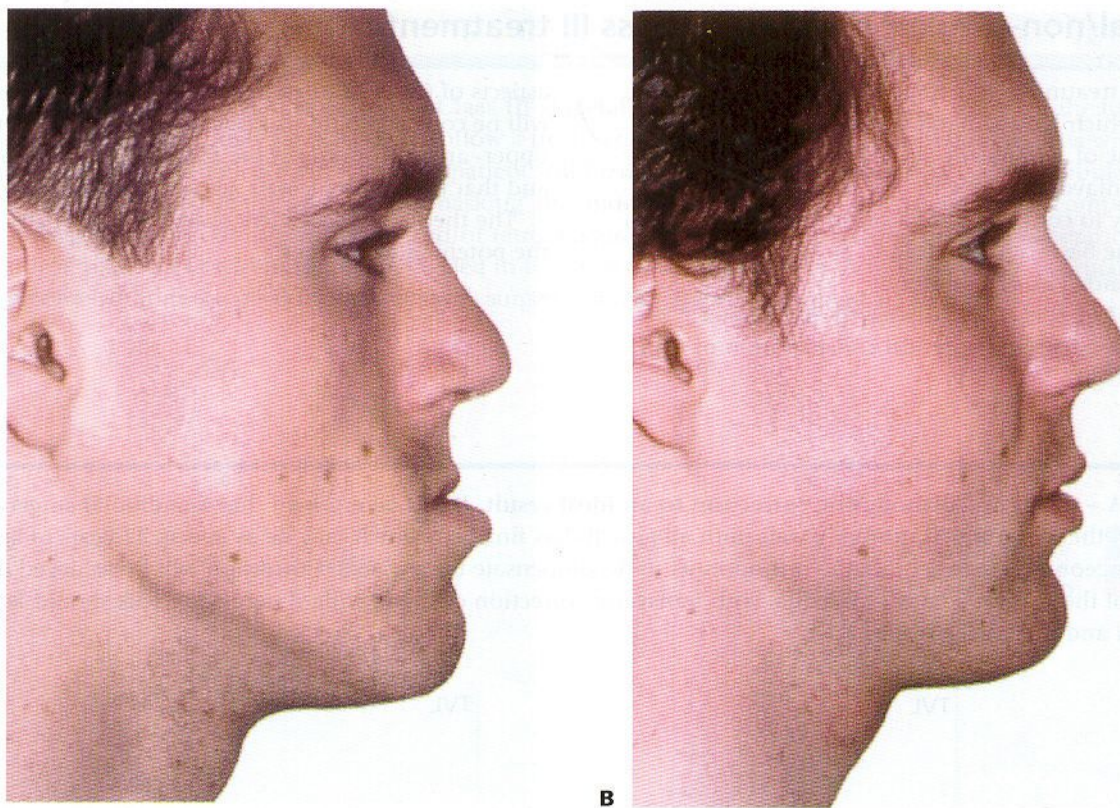


Fig. 8.5 The Arnett analysis became available in September 1999. It offers new levels of sophistication as an aid in diagnosis and treatment planning for orthodontists and surgeons. It emphasizes soft tissue facial measurement, and the numerical printouts are color coded. The analysis is related to the true vertical line (TVL) and has separate norms for males and females. The treated patient shown here, by permission of Dr Arnett, had bi-maxillary surgery to advance the maxilla and set back the mandible. There was also hydroxyapatite grafting of orbital rims.

The surgical/non-surgical decision in Class III treatment

As with Class II treatment, it is important to recognize those Class III cases which have a major skeletal disproportion, either at the time of assessment, or where there is a probability of unfavorable growth. For such individuals, it will be necessary to consider a surgical/orthodontic solution. Treatment on the basis of orthodontics alone should be delayed, or discarded as a possibility.

The STCA of Arnett et al was discussed in Chapter 7 (p. 163). In the following theoretical consideration of some

aspects of Class III treatment, the same seven measurements will be considered, for cases where it is assumed that the upper- and mid-thirds of the facial profile are close to ideal, and that the upper incisors are well positioned.

The theoretical treatment situations, A, B, and C, explain the potential difficulties:

Situation A – a surgical/orthodontic correction to an ideal result. If it is determined that mandibular surgery will be required, then the surgeon will normally wait until all growth has finished, which may be as late as 22 years of age in males. The surgeon will then require the orthodontist to decompensate the incisors. Correction will be achieved by A/P realignment of the mandible and/or maxilla, with transverse correction of the maxilla if necessary. This should lead to an optimal facial and dental result (Fig. 8.6).

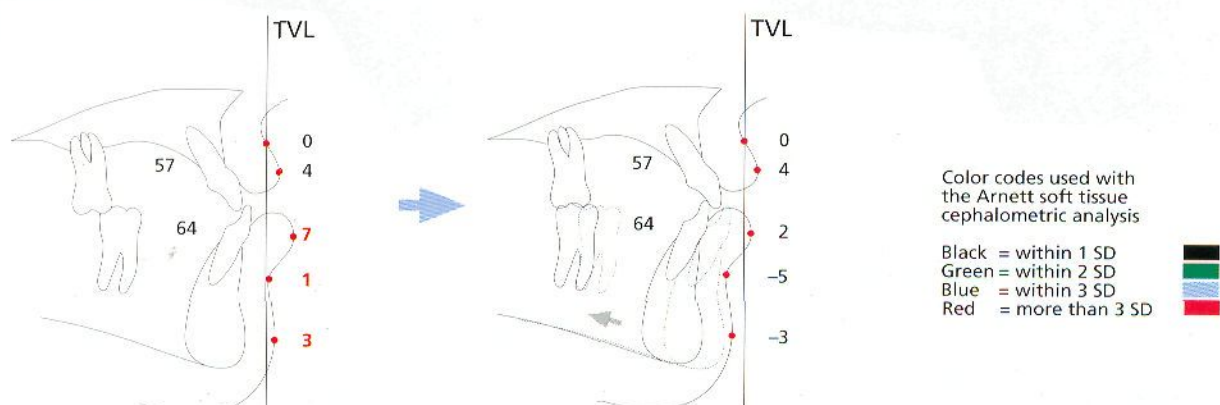


Fig. 8.6 If a combined surgical and orthodontic solution is used to treat this case, a close-to-ideal facial profile and dental outcome should be possible. A 6-mm mandibular set-back will result in measurements to true vertical line (TVL) which are within 1 SD of the ideal.

Situation B – orthodontic masking of a mild Class III skeletal case. As an alternative to 'A' above, if the underlying skeletal discrepancy is mild, it may be decided to follow a treatment plan based on orthodontics alone. This will allow correction to be commenced much earlier, and the patient will be informed of the possibility of late mandibular growth. The orthodontist will then solve the problem by 'masking' the underlying Class III discrepancy by dental compensation. This will involve proclination of upper incisors and/or retroclination of lower incisors. Good patient cooperation with Class III elastics and/or a face mask will normally be needed in this type of treatment. This should lead to an acceptable dental and facial outcome without the need for orthognathic surgery, which patients wish to avoid (Fig. 8.7).

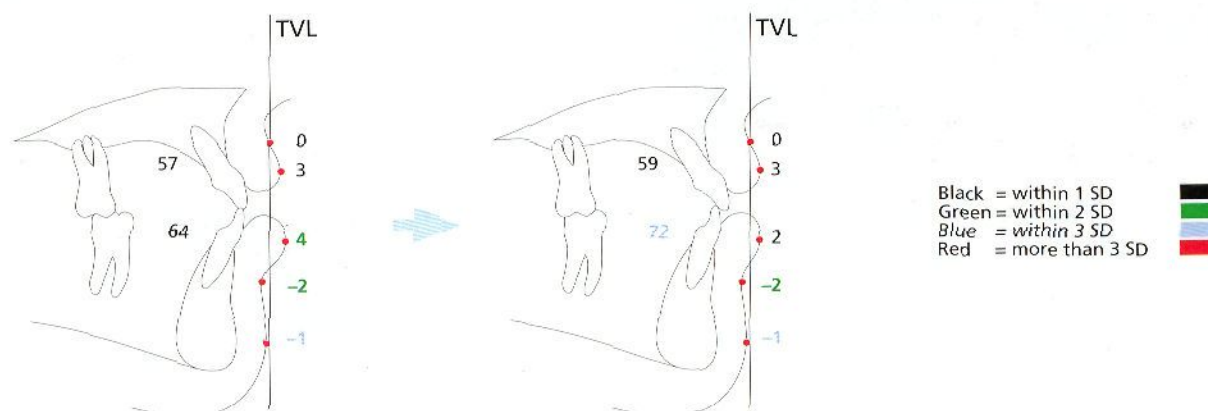


Fig. 8.7 In this mild Class III case, a treatment plan can be based on orthodontic tooth movements to mask the slight underlying skeletal discrepancy. This can lead to a good dental outcome, and some improvement in facial profile measurements. In this theoretical representation, the upper incisors were proclined 2° and the lowers were retroclined 8°.

Situation C – late mandibular growth. After orthodontic masking of a mild Class III malocclusion, late mandibular growth can occur, especially in males. This is a difficult situation to manage. Sometimes the patient will find the late change in dental and facial outcome acceptable, and seek no further treatment. However, if mandibular surgery is deemed necessary, there is limited scope for facial improvement from the surgery, because of the dentally compensated teeth (Fig. 8.8). The incisors will need to be decompensated by orthodontics before surgery, if there is to be an optimal facial benefit from the surgery.

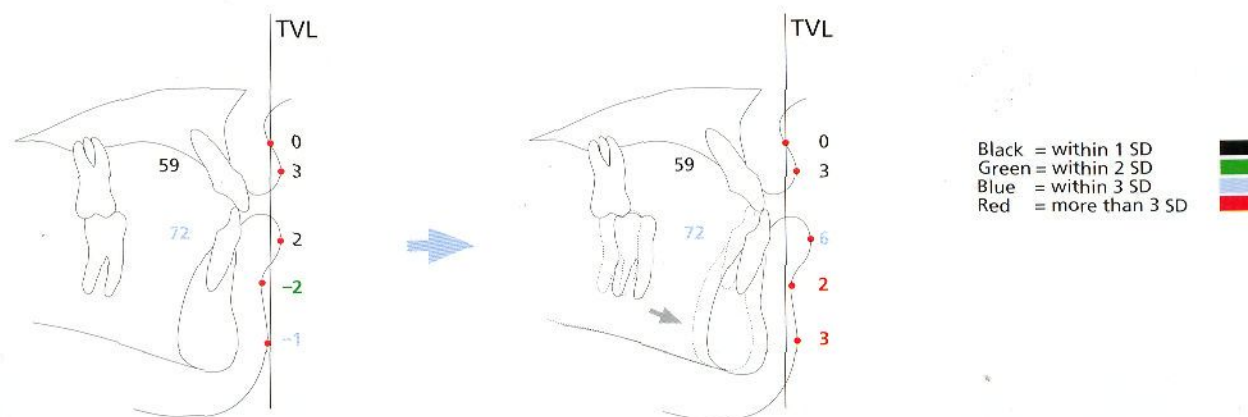


Fig. 8.8 In some cases, late mandibular growth occurs after the type of treatment shown in 'B' above. This is difficult to manage. If a decision is made to carry out mandibular surgery, it is often necessary to provide further orthodontic treatment to decompensate the incisors, before the surgery.

The posterior 'squeezing out' effect of molar crowding

There has been discussion of posterior crowding as a factor in the development of Class III malocclusions.³ The theory suggests that a squeezing out effect can occur because of crowding in the molar regions, which can contribute to an anterior open-bite malocclusion in a mandible with poor vertical growth in the ramus area (Fig. 8.9). Alternatively, good ramus growth can lead to a Class III malocclusion.

This concept is not well understood, and has not been fully investigated. However, some carefully selected Class III cases⁴ (see Case KB, p. 242) and some open-bite cases⁵ respond well to a treatment approach involving second molar extractions. This suggests some validity to the theory of a squeezing out effect. It may be an important etiological factor in some cases.

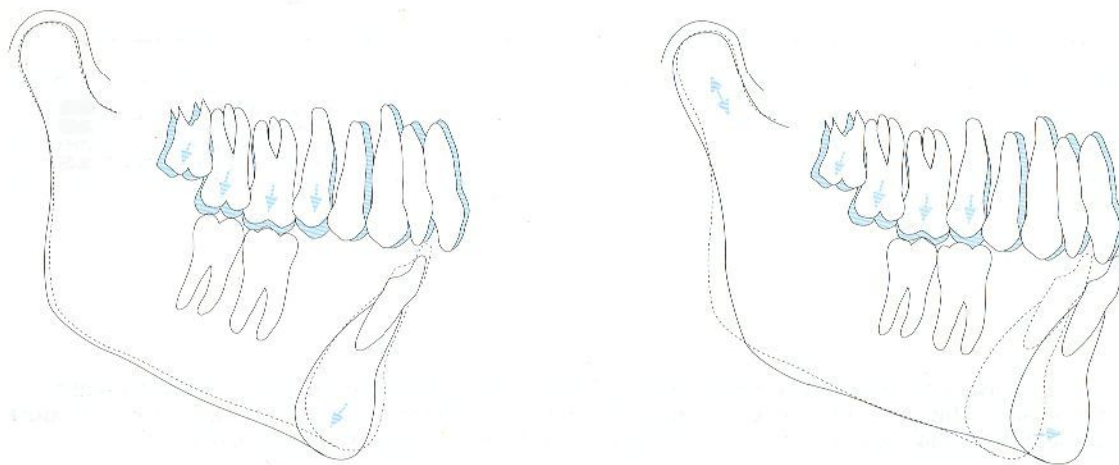


Fig. 8.9 Posterior crowding has been discussed as a factor in the development of some Class III malocclusions and anterior open bite malocclusions. Posterior 'squeezing out effect' can be relieved by extraction of second permanent molars in selected cases, which is helpful to treatment mechanics.

Class III mechanics

Inter-maxillary Class III elastics (Fig. 8.10) are most helpful in orthodontic (non-surgical) correction of Class III cases. They tend to produce lower incisor retroclination, upper incisor proclination, and A/P correction of the molar relationship (Fig. 8.11). All components of the Class III elastic force can therefore be helpful in reaching treatment goals in average or low angle cases. With Class II elastics (Fig. 8.12) the vertical components may be perceived as disadvantageous in higher angle cases.

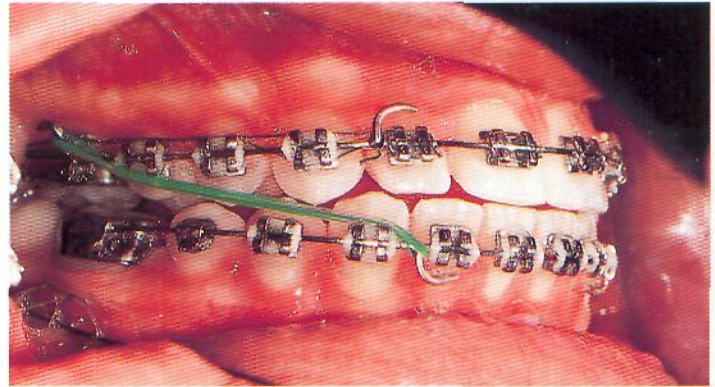


Fig. 8.10 Intermaxillary Class III elastics.

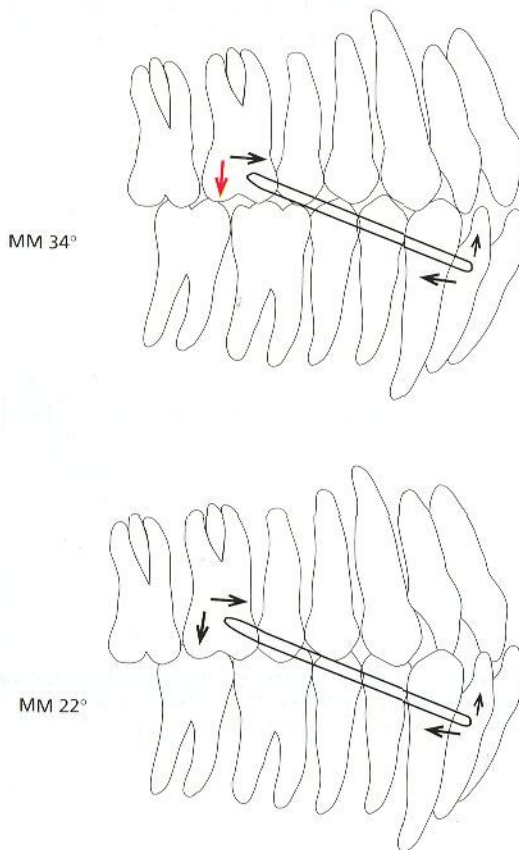


Fig. 8.11 This shows the force vectors involved in the use of Class III elastics. In low angle deep bite cases all four vectors are helpful. However, in high angle Class III cases with an open bite tendency, upper molar extrusion is contra-indicated. This can be counteracted with a palatal bar (Fig. 5.29, p. 107).

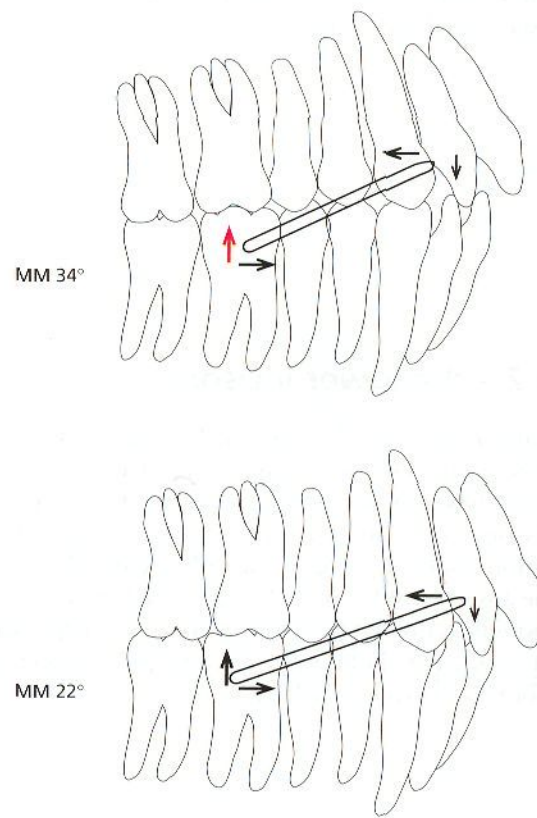


Fig. 8.12 This shows the force vectors involved in the use of Class II elastics. In low angle Class II cases all four vectors are helpful. (The vertical component in the upper incisor region is balanced by curve of Spee in the upper archwire, and hence does not contribute to unwanted bite deepening). In high angle Class II cases upper molar extrusion should be avoided. In such cases short Class II elastics can be considered.

THE FOUR-STAGE TREATMENT PLANNING PROCESS FOR CLASS III CASES

The treatment planning sequence is similar to the Class II method, and the reader may wish to review pages 166 and 167. The four stages in planning are described below:

Stage 1 – setting a PIP for the upper incisors

This involves deciding what would be the ideal position for the upper incisors. Is this achievable? If not, can orthodontic tooth movements be used to reach a position which is less than ideal, but acceptable? Or will maxillary surgery be needed to reach an acceptable upper incisor position? In this way, a PIP (planned incisor position) for the upper incisors can be established (Fig. 8.13).

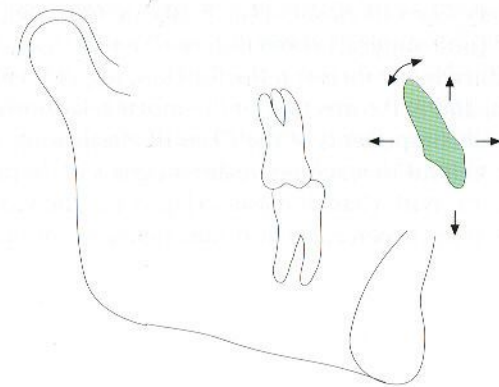


Fig. 8.13 The first stage in Class III treatment planning concerns upper incisor position. It is necessary to determine an ideal position and then decide whether it can be achieved. If not, a modified position may be appropriate, which is less than ideal, but acceptable. In this way a 'planned incisor position', or PIP, is determined.

Stage 2 – the lower incisors

Is it possible to position the lower incisors in good relationship to the PIP for the upper incisors? Can we achieve the required lower incisor position by orthodontics alone? In Class III cases with mandibular excess, this is frequently the key question, especially in growing individuals (Fig. 8.14). Often the answer will be 'probably, provided growth will not be unfavorable'. Alternatively, the answer may be 'possibly, but there is concern about future growth, and it is preferable to wait for this to express itself' (p. 234).

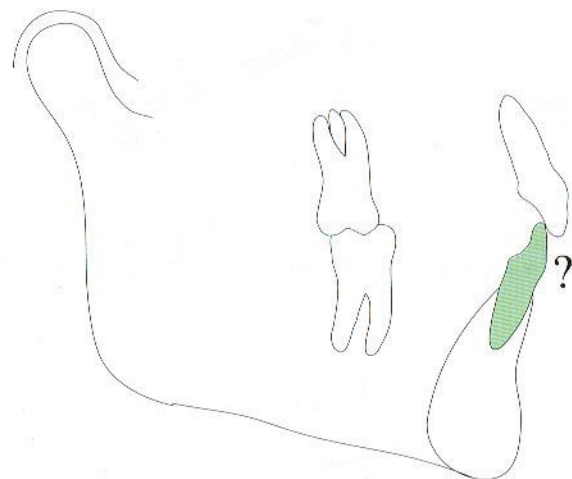


Fig. 8.14 The second stage of treatment planning involves positioning of the lower incisors. This is frequently a key concern in Class III cases with mandibular excess.

Stage 3 – the remaining upper teeth

In the discussion on Class II treatment planning (p. 167), stage 3 of the process concerned the remaining lower teeth, followed by stage 4 – the remaining upper teeth. In Class III treatment planning the opposite applies. It is beneficial to evaluate the remaining *upper* teeth at stage 3. If upper premolar extractions are necessary (usually second premolars) then it is normally logical to extract lower first premolar, in a Class III case. However, if the upper arch can be treated without extractions, then a range of lower arch options needs to be considered.

The third stage therefore involves deciding how to position the rest of the upper teeth to fit the PIP for the upper incisors. It normally assists Class III treatment mechanics if upper arch extractions can be avoided. The dental VTO will confirm the required movement of molars and canines (Fig. 8.15).

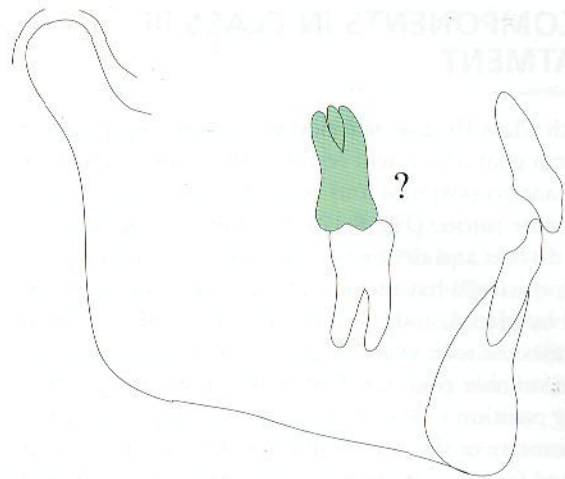


Fig. 8.15 The third stage in Class III treatment planning involves deciding on treatment mechanics to position the rest of the upper teeth correctly to fit the PIP for the upper incisors.

Stage 4 – the remaining lower teeth

How can the rest of the lower teeth be positioned to fit the planned lower incisor position (Fig. 8.16)? Does the case require lower extractions to deal with lower arch crowding, or to allow sufficient retraction of the lower incisors? Lower premolar extractions assist in the retraction of lower incisors, and are helpful to Class III treatment mechanics in many cases. The dental VTO⁶ can be used to reach a correct decision. In some Class III marginal extractions cases, second molars may be considered (Case KB, p. 242).

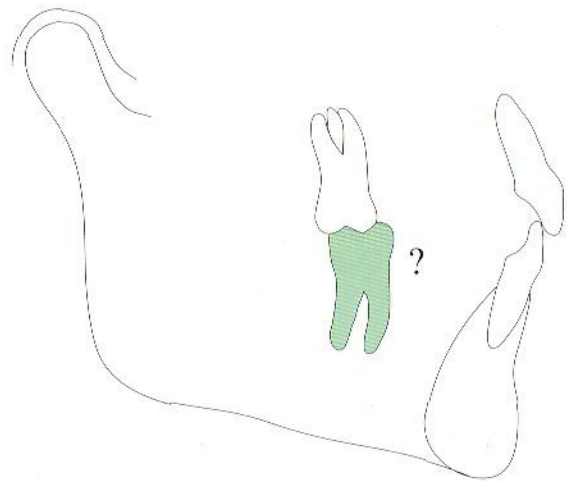


Fig. 8.16 The final stage of Class III treatment planning. It is necessary to assess lower arch crowding or spacing, and decide how to position the rest of the lower teeth to fit the planned lower incisor position.

8 • AN OVERVIEW OF CLASS III TREATMENT

PIP COMPONENTS IN CLASS III TREATMENT

For each Class III case, it is necessary to set a PIP as a treatment goal which will result in the upper incisors having correct antero-posterior and vertical positioning, with appropriate torque (Fig. 8.17). It is beyond the scope of this text to discuss and define precise goals. However, each orthodontist will have a view about where the upper incisor should be placed, and there should be broad consensus in most cases. As with Class II cases, before reaching a decision about a suitable goal, it is first necessary to analyze the existing position of the incisors, using either conventional cephalometry or the Arnett analysis. The components are as described for Class II cases (p. 168). The same approach and values should be used when analyzing the pre-treatment upper incisor position for Class III cases.

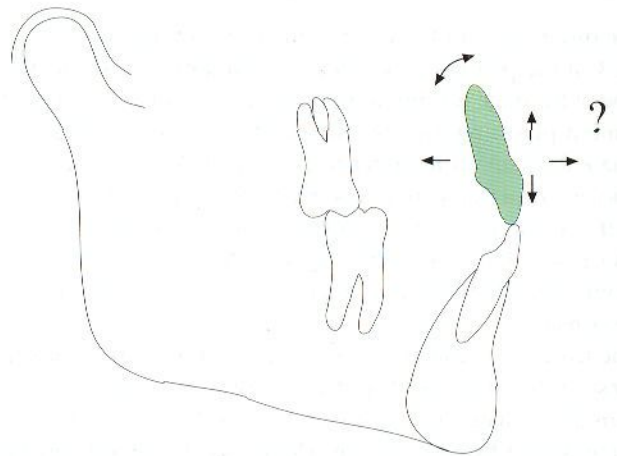


Fig. 8.17 For each Class III case, at the start of treatment planning it is necessary to establish a PIP which will result in upper incisors having correct A/P and vertical positioning, with appropriate torque.

UPPER INCISOR MOVEMENT IN CLASS III TREATMENT

Having set a PIP for a case, controlled upper incisor movement will be needed to reach the goal. It is helpful to plan the upper incisor tooth movements in isolation, and then consider the lower tooth movements. The lower arch may be disregarded at this stage, except as a possible source of anchorage when using Class III elastics. In the following pages, recommended MBT™ mechanics will be described for upper incisor tooth movements in Class III treatment situations.

In mild Class III cases, with a normal maxilla but mandibular excess, the pre-treatment upper incisor position may be close to the PIP. In this situation, the case may require relatively little movement of the upper incisors. However, in many Class III cases, there will be a requirement to move the upper incisors mesially. In some maxillary deficiency Class III cases, it can be a challenge to achieve the required mesial movement without excessive proclination. If a Class III case

requires mesial movement of upper incisors, it can be achieved in two ways:

1. By proclination and mesial movement of upper incisors within the available bone (Fig. 8.18). Many Class III cases require mesial movement of upper incisors, to keep pace with the growing mandible. When upper incisors are proclined forwards, each 2.5° of proclination creates approximately 1 mm of space per side, or 2 mm in total. For this reason upper premolar extractions are not advisable in many Class III cases. If upper premolars are extracted it can be difficult or impossible to procline upper incisors.
2. By mesial movement of the maxillary bone (Fig. 8.19) as a result of normal growth or orthodontic procedures.

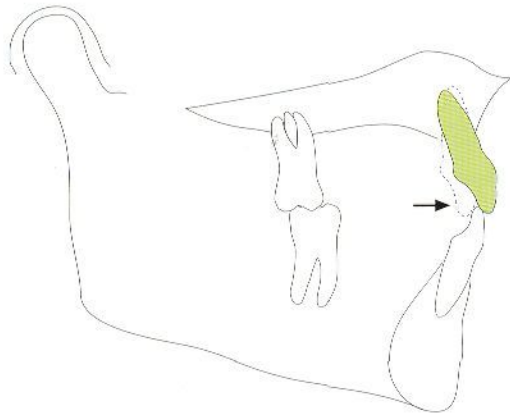


Fig. 8.18 Mesial movement of upper incisor crowns by proclination.

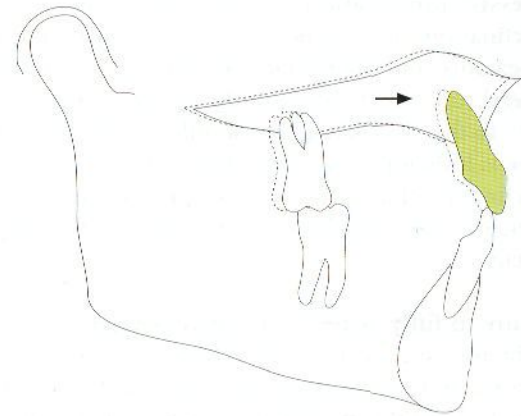


Fig. 8.19 Mesial movement of upper incisor crowns by mesial movement of the maxillary bone, as a result of growth or orthodontic procedures.

Mesial movement of upper incisors within the bone

During tooth leveling with the opening wires, there is a tendency for upper incisors to move mesially due to bracket tip, as previously discussed. In Class III cases, this is normally beneficial, and moves the upper incisors towards PIP. Likewise, at the rectangular HANT and the rectangular steel wire stages, the A/P expansion and torque effects tend to produce beneficial changes for most Class III cases. This can be further augmented by the use of Class III elastics. Because of these spontaneous tooth movements during tooth leveling and aligning, the early management of the upper arch in mild Class III cases is normally straightforward.

Limits to mesial movement of upper incisors

There are clear clinical limits which have to be observed when moving upper incisors mesially. Problems can develop in seemingly easy treatments, and the risks lie in two areas:

1. **Excessive proclination.** It is necessary to avoid excessive proclination of the upper incisors, otherwise unesthetic appearance and inadequate function will result. As a general rule, proclination of the upper incisors beyond 120° to the maxillary plane should be avoided, although there is individual variation (Fig. 8.20). In some cases, less proclination than 120° may be appropriate. Gingival recession and long clinical crowns can result from excessive proclination.
2. **Failure to fully achieve a positive overjet.** This can be due to the forward position of the lower incisors, or other reasons, and the resulting bite can be difficult to manage (Fig. 8.21). If this is allowed to persist, then there is a risk of enamel damage and/or root resorption. Accordingly, it is unwise to attempt to correct a Class III incisor relationship by orthodontic procedures alone, unless it is clear from the outset that full correction can be achieved, and a near normal overjet obtained.

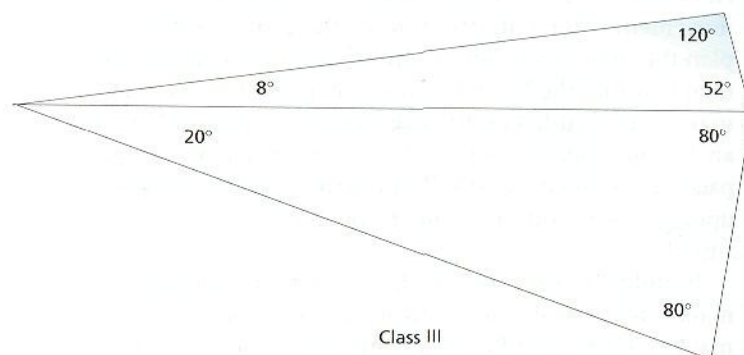


Fig. 8.20 Excessive proclination of upper incisors beyond 120° to the maxillary plane should be avoided as a general rule, although there is individual variation.

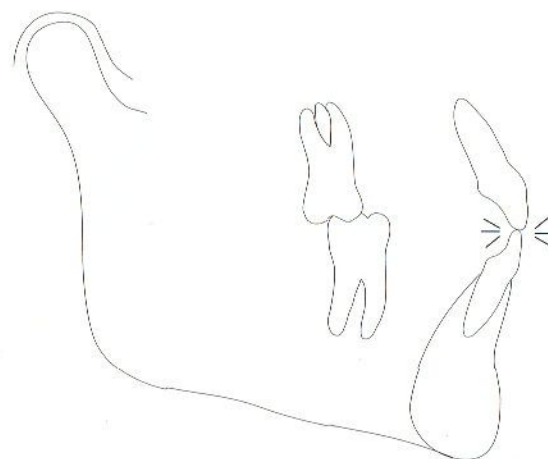


Fig. 8.21 It is unwise to attempt to correct a Class III incisor relationship by orthodontics alone, unless it is clear that a normal overjet can be achieved. A persistent edge-to-edge bite can be associated with root resorption and/or enamel damage.

Mesial movement of maxillary bone due to growth

Maxillary growth cannot be relied on as a useful factor in correction of Class III malocclusions. Generally in this type of case, maxillary growth will not be favorable or helpful in reaching the PIP for the upper incisor.

Mesial movement of maxillary bone due to orthodontic treatment

In growing individuals who have maxillary deficiency, consideration can be given to treatment procedures which will encourage orthopedic change within the maxillary bone (Fig. 8.22). These can include rapid maxillary expansion, and the use of reverse headgear, but there is much controversy and uncertainty surrounding the effect and stability of this type of treatment. However, there is some evidence in the literature⁷ that favorable mesial change in the maxilla can be produced, thereby assisting in mesial movement of the upper incisors toward PIP.

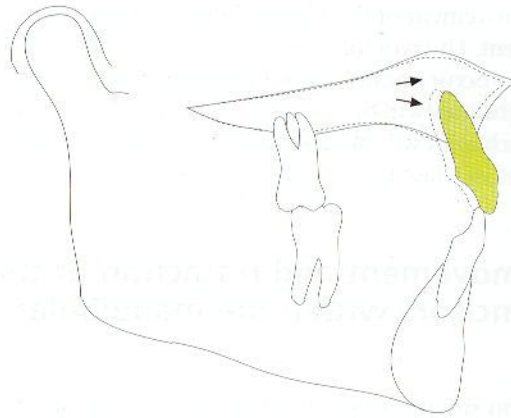


Fig. 8.22 If favorable orthopedic change can be achieved in the maxilla, this assists in mesial movement of upper incisors towards PIP.

LOWER INCISOR MOVEMENT IN CLASS III CASES

Distal movement of the lower incisors can be achieved by distal movement of the teeth within the mandibular bone, or by distal movement of the mandible itself, when there is a displacement. Unfavorable mesial movement of the lower incisors can occur because of mandibular growth. Each of these possibilities will be reviewed in turn and recommended MBT™ mechanics will be described for lower incisor tooth movements in Class III treatment situations.

Distal movement and retraction of the lower incisors within the mandibular bone

In most non-surgical Class III treatments, it is helpful to retract and retrocline the lower incisors (Fig. 8.23). This can compensate for mild mandibular prognathism or mild maxillary retrognathism, and hence mask the underlying skeletal discrepancy. The anatomy of the mandibular bone in the lower incisor region places limits on what should be attempted. Retraction and retroclination beyond a figure of approximately 80° to the mandibular plane (Fig. 8.24) is undesirable, because of the risk of dehiscence and lack of bone support for the over-retracted incisors. Also, dental esthetics and function will be adversely affected. The figure

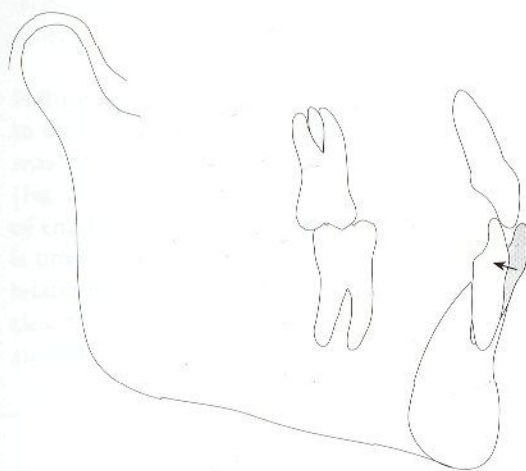


Fig. 8.23 Retraction and retroclination of lower incisors is helpful in most non-surgical Class III treatments.

of 80° compares with the Michigan normal¹ of approximately 95° . Although 80° is a good rule of thumb, in some cases a limit of 85° may be appropriate, and a case-by-case assessment is recommended.

The required retraction and retroclination of the lower incisors is normally achieved with the assistance of Class III elastics, and treatment mechanics are easier in cases where lower teeth have been extracted. Lower first premolar extractions are most favorable in assisting lower incisor distal movement, but loss of lower second molars can also be considered (Case KB, p. 242).

If the lower arch is managed on a non-extraction basis, Class III mechanics can be used to produce some retraction and retroclination of the lower incisors. This can produce distal tipping of the lower premolars and molars, which in turn reduces the available space for the lower third molars (Case MS, p. 241). Early removal of lower third molars can be considered in some cases.

A non-extraction approach to Class III treatment may not achieve sufficient lower incisor movement for the needs of the case. Correction of the malocclusion may be possible, but not over-correction. Thus, there is no provision in the result for any late growth changes, which occur relatively frequently in Class III cases, especially among male patients.

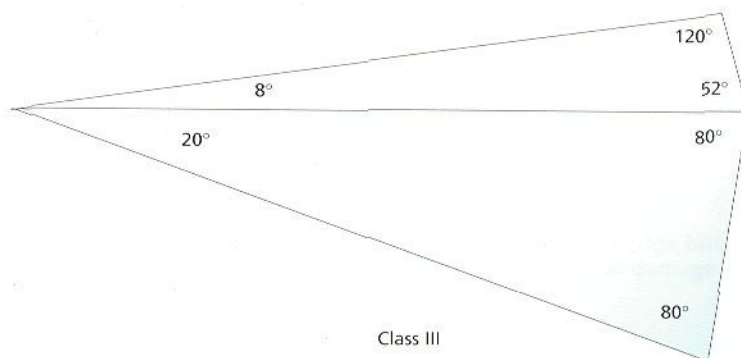


Fig. 8.24 As a general rule, retraction and retroclination of lower incisors beyond 80° to the mandibular plane is undesirable.

Distal movement of mandibular bone – distal repositioning

In many Class III cases, there is a mesial displacement of the mandible at the start of treatment. As treatment progresses, the mandible repositions distally, to a position with the condyles centered in the fossae. This favorable change can be predicted at the treatment planning stage, and is a useful adjunct to distal movement of the lower incisors within the facial complex.

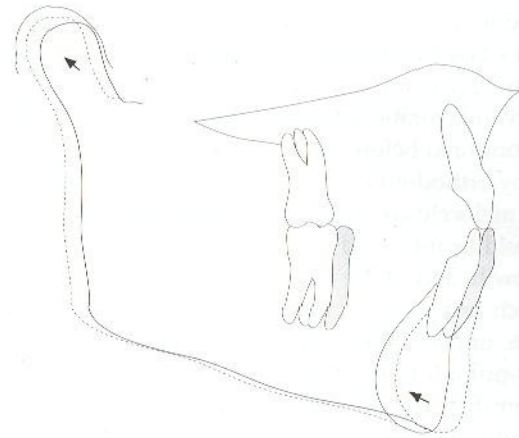


Fig. 8.25 In many Class III treatments, a mesial mandibular displacement is evident at the start of treatment. As the mandible repositions distally during treatment, and condyles become centered in the fossae, lower incisors move distally in the facial complex.

Distal movement of mandibular bone – restriction of growth?

In the past, much attention was given to the use of orthopedic devices, such as chin caps (Fig. 8.26), to restrict mandibular growth in Class III cases with mandibular prognathism. Clinical experience and research evidence⁸ combine to suggest that there is little advantage in using orthopedic measures to attempt to restrict the final length of the mandible. Accordingly, the authors have abandoned the use of chin caps and similar devices.



Fig. 8.26 Clinicians have achieved little success with chin caps and other orthopedic devices, intended to restrict mandibular growth in Class III cases. The authors have abandoned them.

Mesial movement of mandibular bone – Class III growth

This is a major factor in the treatment and subsequent retention of Class III patients, especially males. As mentioned previously (p. 226), any case which appears to have substantially unfavorable Class III growth patterns should be carefully monitored before making a commitment to correction by orthodontic means alone. If a decision is made to treat the malocclusion with orthodontics alone, every patient should be informed of the unpredictable nature of Class III growth, and of the implications of any unfavorable growth which may occur in the retention period. As described on page 226, unfavorable growth can be difficult to manage for the post-orthodontic patient, and therefore care should be taken to identify those cases which should be managed surgically from the outset. In particular, irreversible extraction decisions should not be made too early.

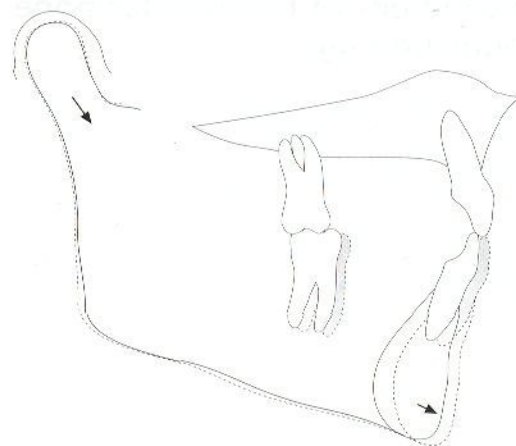


Fig. 8.27 Unfavorable Class III growth can be difficult to manage for the post-orthodontic patient.

REFERENCES

- 1 Riolo M et al 1974 Atlas of craniofacial growth. Center for Human Growth and Development, University of Michigan
- 2 McNamara J A 1984 A method of cephalometric evaluation. *American Journal of Orthodontics* 86:449–469
- 3 Sato S, Suzuki Y 1988 Relationship between the development of skeletal mesio-occlusion and posterior tooth-to-denture base discrepancy. Its significance in the orthodontic correction of skeletal Class III malocclusion. *Journal of the Japanese Orthodontic Society* 48:796–810
- 4 Bennett J, McLaughlin R P 1997 Orthodontic management of the dentition with the preadjusted appliance. Isis Medical Media, Oxford (ISBN 1 899066 91 8) pp. 344–350. Republished in 2002 by Mosby, Edinburgh (ISBN 07234 32651)
- 5 Bennett J, McLaughlin R P 1997 Orthodontic management of the dentition with the preadjusted appliance. Isis Medical Media, Oxford (ISBN 1 899066 91 8) pp. 338–343. Republished in 2002 by Mosby, Edinburgh (ISBN 07234 32651)
- 6 McLaughlin R P, Bennett J 1999 An analysis of orthodontic tooth movement – the dental VTO. *Revista Espanola de Ortodoncia* 29:2 10–29
- 7 Pangrazio-Kulbersh V, Berger J, Kersten G 1998 Effects of protraction mechanics on the midface. *American Journal of Orthodontics and Dentofacial Orthopedics* 114:484–491
- 8 Ishikawa H et al 1998 Individual growth in Class III malocclusion and its relationship to the chin cap effects. *American Journal of Orthodontics and Dentofacial Orthopedics* 114:337–346

CASE MS

A male patient, aged 13.11 years, with a slight Class III skeletal pattern (ANB -1°) and MM average (25°). Lower incisors were retroclined at 84° to the mandibular plane. There was a mild Class III facial profile.

Molar relationship was slightly Class III bilaterally, and there was a Class III incisor relationship, with lower incisors crowded and retroclined. There was mild upper anterior crowding with the left first premolar in crossbite. Good-sized third molars were developing in satisfactory positions. Second molar extraction was considered and discussed, but after discussion with the family, treatment proceeded on a non-extraction basis.

www.allislam.net
Problem

Standard metal brackets were used for optimal control. The upper arch was fully set up with a .016 HANT wire. Bracketing of lower incisors was delayed to allow separation and enamel reduction. In this way, proclination of lower incisors during alignment could be restricted. Sectional .015 multistrand wires were used in the lower arch.



Fig. 8.27



Fig. 8.30

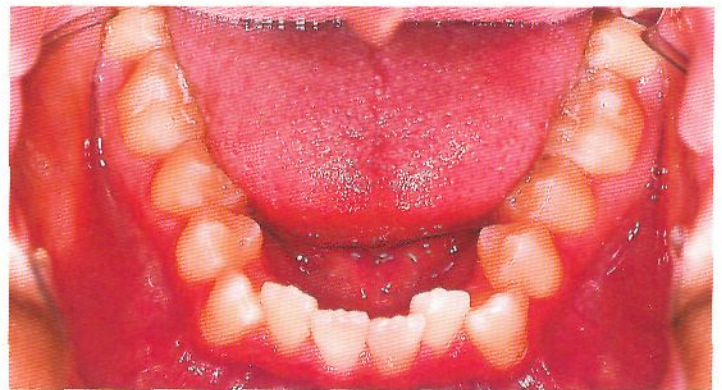


Fig. 8.33



Fig. 8.36



Fig. 8.28

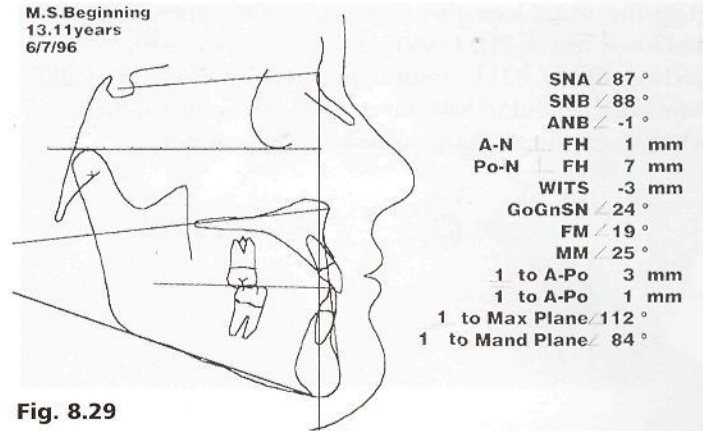


Fig. 8.29



Fig. 8.31



Fig. 8.32

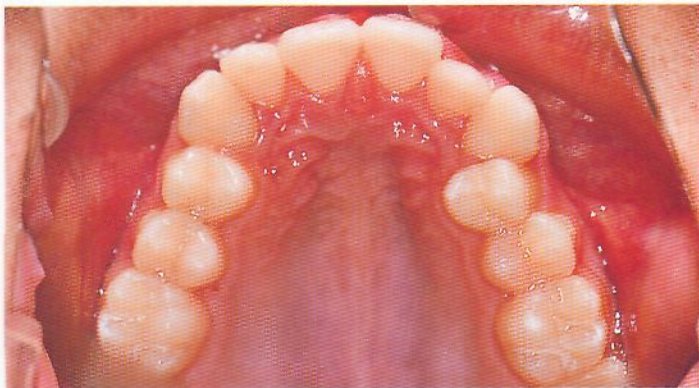


Fig. 8.34

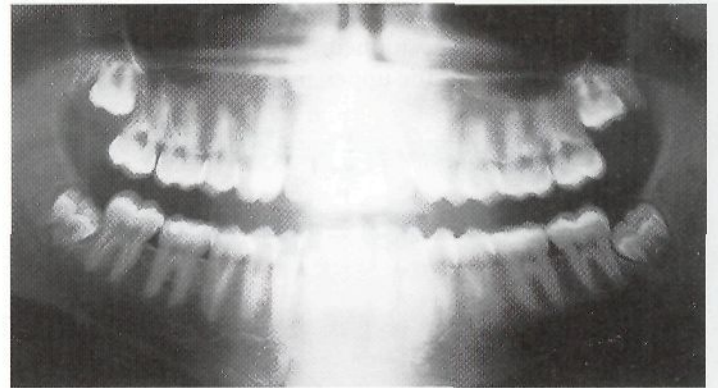


Fig. 8.35



Fig. 8.37

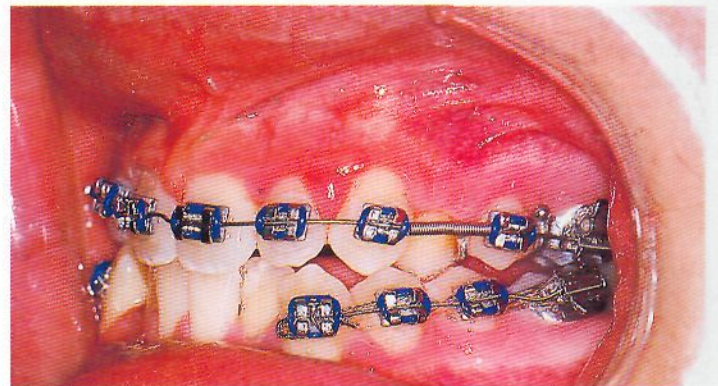


Fig. 8.38

Here, the case is seen after 10 months of treatment. Upper and lower rectangular HANT wires are in place, with a .036 'jockey' wire (p. 82) to assist upper arch expansion. It would have been helpful to have inverted lower canine brackets when setting up this case, to assist torque control.



Fig. 8.39

Lower second molars had erupted sufficiently to permit banding at this stage. The .019/.025 lower HANT wire is effective in producing early correction, and this wire does not permanently distort due to mastication, as can happen with steel wires in the lower second molar region.

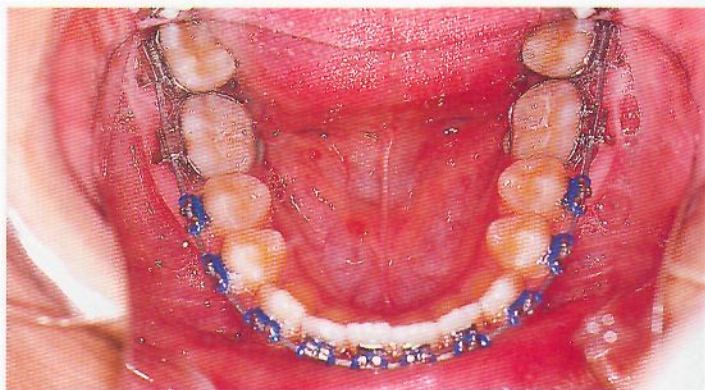


Fig. 8.42

After 13 months of treatment, the lower first molar bands and several brackets were repositioned, and rectangular HANT wires were continued in the upper and lower arches.

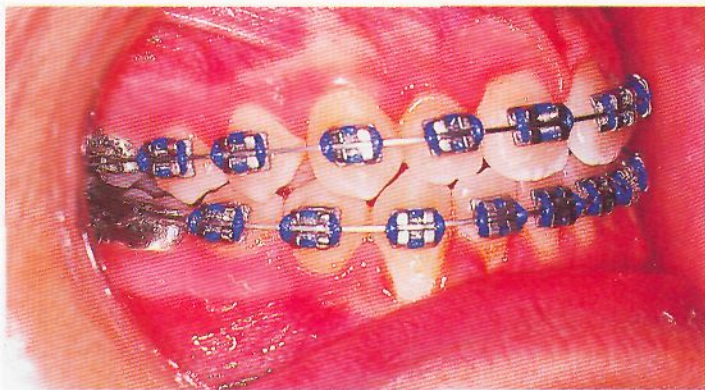


Fig. 8.45

Normal upper and lower steel .019/.025 rectangular wires were used, with some upper archwire expansion to maintain a correct bucco-lingual molar relationship.

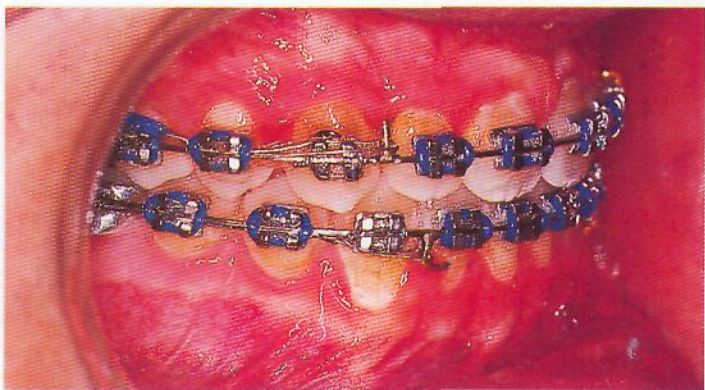


Fig. 8.48



Fig. 8.40



Fig. 8.41

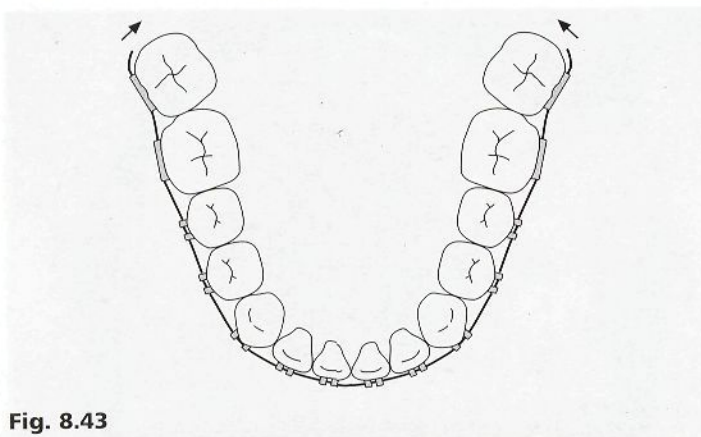


Fig. 8.43

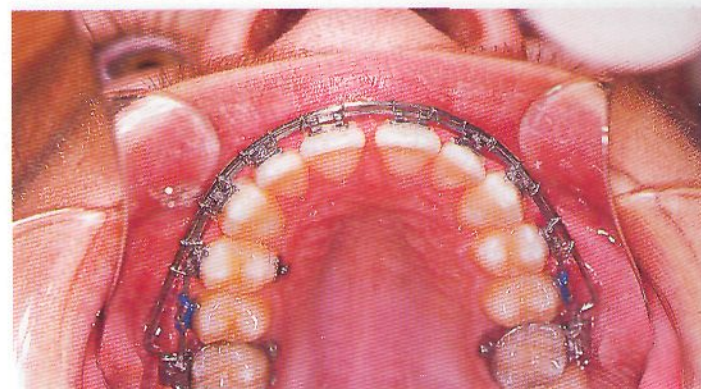


Fig. 8.44

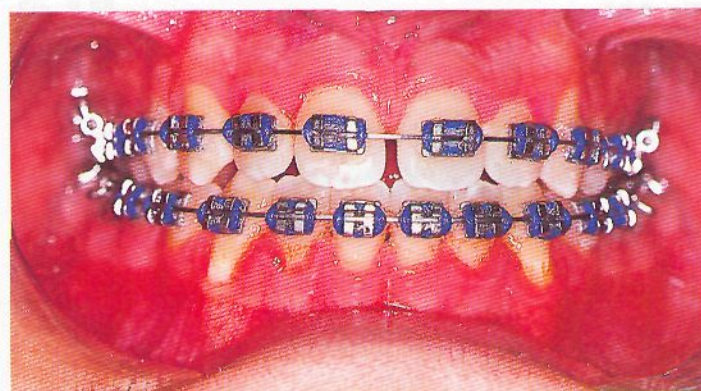


Fig. 8.46

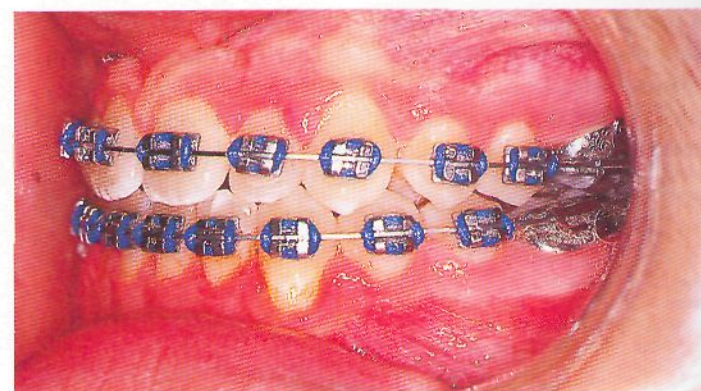


Fig. 8.47

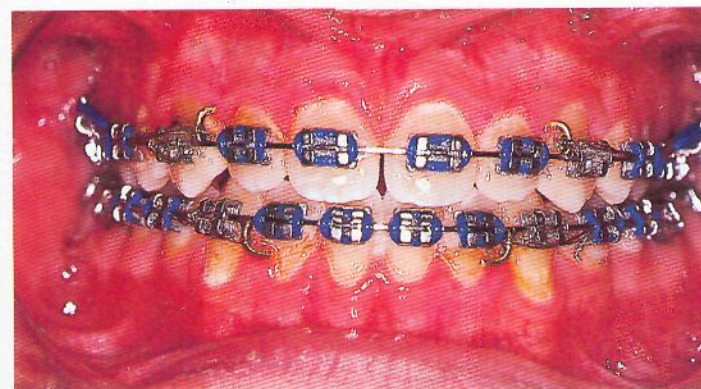


Fig. 8.49

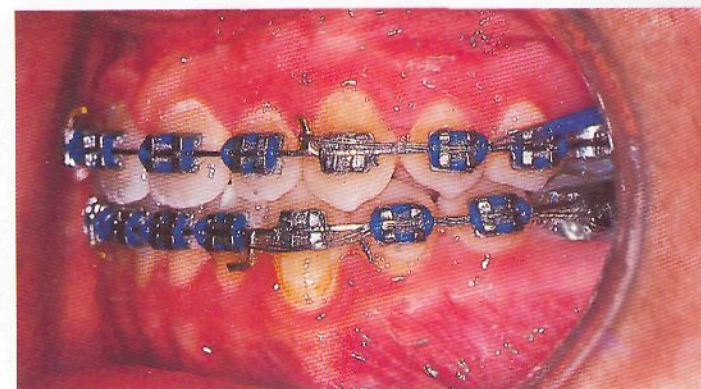


Fig. 8.50

Frontal and buccal view after appliance removal. Active treatment time was 26 months.

A good dental result was obtained, but the panoramic radiograph shows impaction of lower third molars. The patient was referred to a surgeon to discuss extraction of third molars. With hindsight, the third molars could have been extracted earlier in the treatment. This could have helped the Class III treatment mechanics and avoided difficult impactions.

A pleasing mild Class III profile. Little growth occurred during treatment. There is some risk of relapse from late mandibular growth. Extraction of second molars could have produced a result where slight late growth could be more easily managed, and where surgical extractions could have been avoided.



Fig. 8.51

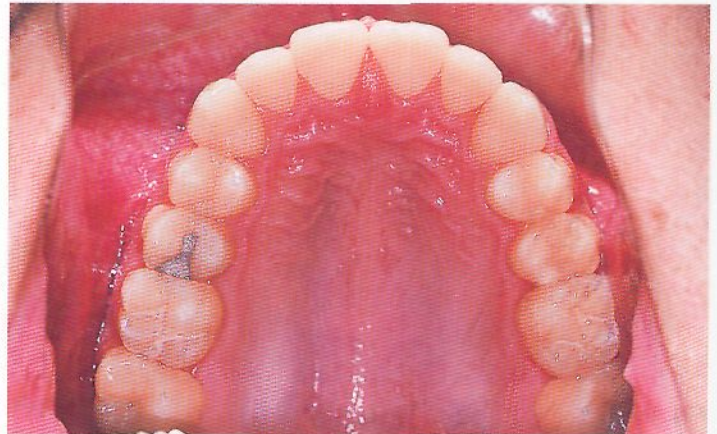


Fig. 8.54

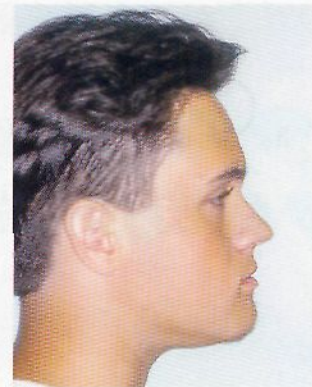


Fig. 8.57

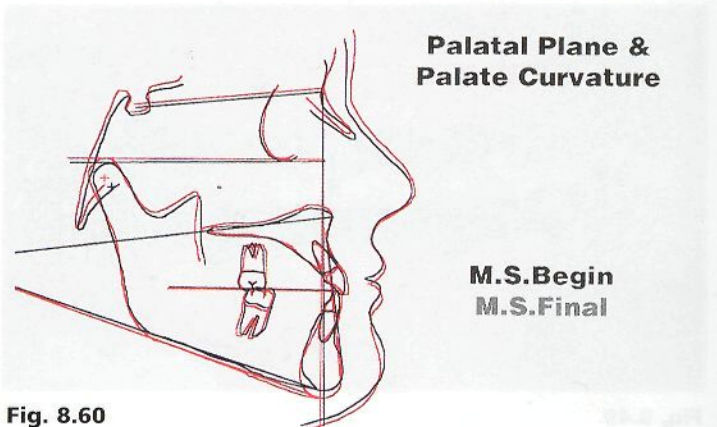


Fig. 8.60

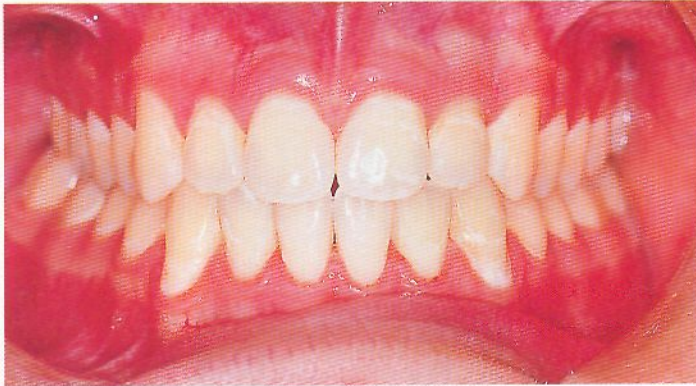


Fig. 8.52



Fig. 8.53

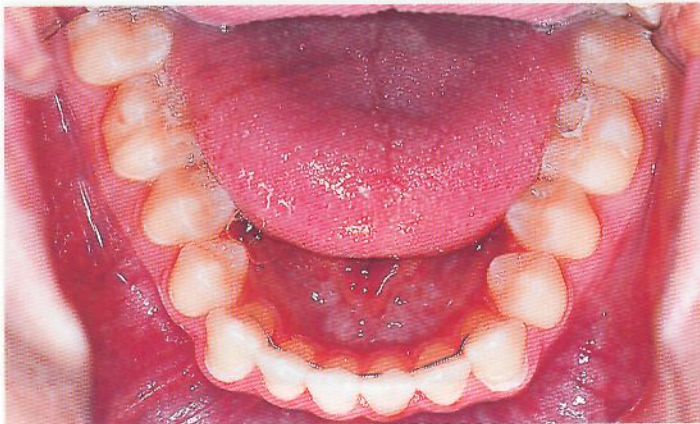


Fig. 8.55

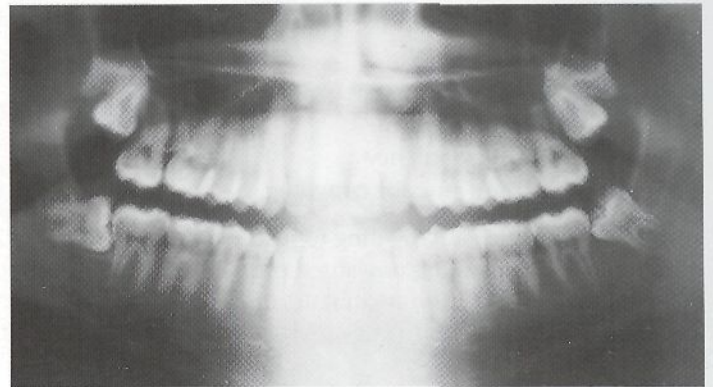


Fig. 8.56



Fig. 8.58

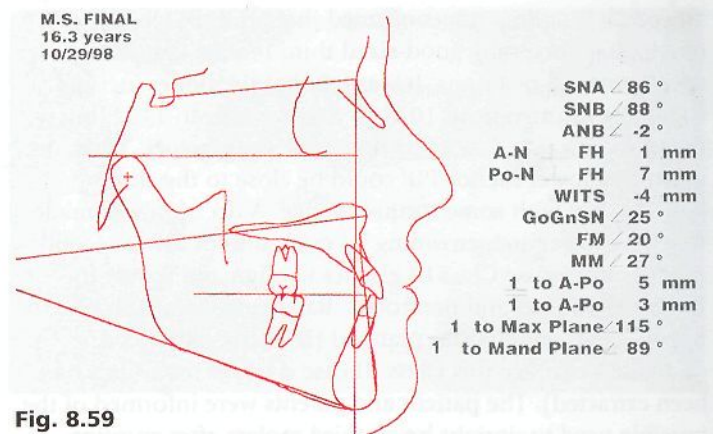


Fig. 8.59

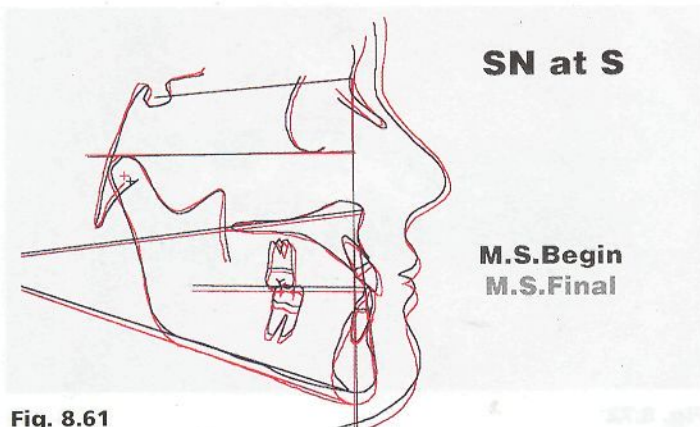


Fig. 8.61

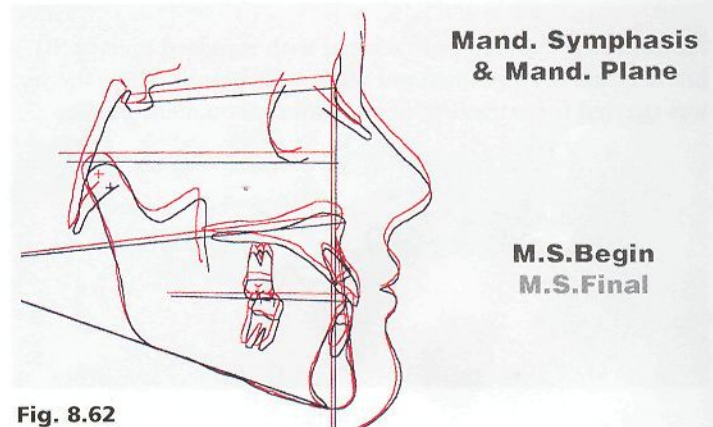


Fig. 8.62

CASE KB

This female patient was aged 13.4 years and showed a slightly high-angle pattern (MM 31°) and mild Class III dental bases (ANB 1°). There was pleasing balance and harmony to the facial profile.

Molar relationship was Class I, but there was a mild Class III incisor relationship, with reduced overbite. Lower incisors were crowded and retroclined, and there was slight upper arch crowding.

The following features contributed to the extraction decision in this case:

- A good, or maybe slightly flat profile
- Slightly high angle pattern
- Anterior open bite tendency
- Slight to moderate anterior crowding.

There was not sufficient crowding to justify premolar extractions without risking unwanted profile change. On the other hand, non-extraction treatment could lead to anterior bite-opening.

The panoramic radiograph confirmed that all teeth were developing, including good-sized third molars in good developmental positions. It was felt that the upper incisors should be torqued from 107° to a figure near to 115°, but that the vertical and A/P positions were satisfactory. Thus, the upper and lower incisor PIP could be close to the starting position, but with some torque change. A decision was made to relieve lower arch crowding by extraction of lower second molars, and to use Class III elastics to align and retract the lower first molars and premolars. Balancing extraction of upper second molars was planned (it would have been difficult to manage this Class III case if upper premolars had been extracted). The patient and parents were informed of the possible need to upright lower third molars after eruption.

All teeth were banded or bracketed with standard metal MBT™ brackets and .015 multistrand wires were placed. The patient was referred for extraction of all second permanent molars.



Fig. 8.63



Fig. 8.66

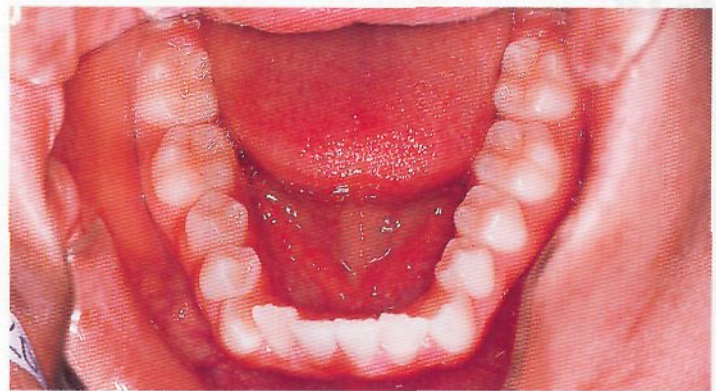


Fig. 8.69



Fig. 8.72



Fig. 8.64

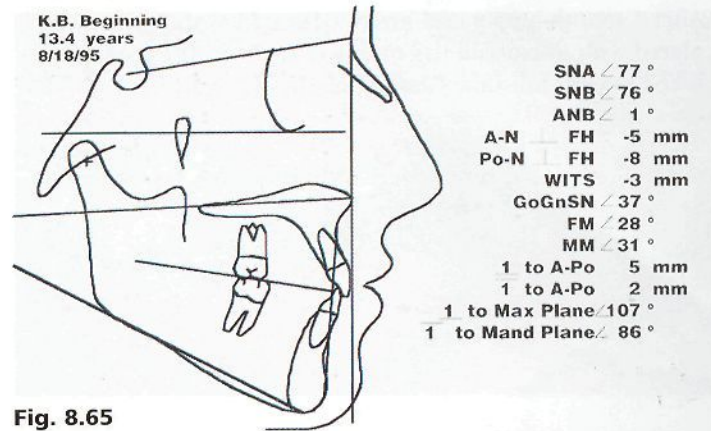


Fig. 8.65



Fig. 8.67



Fig. 8.68

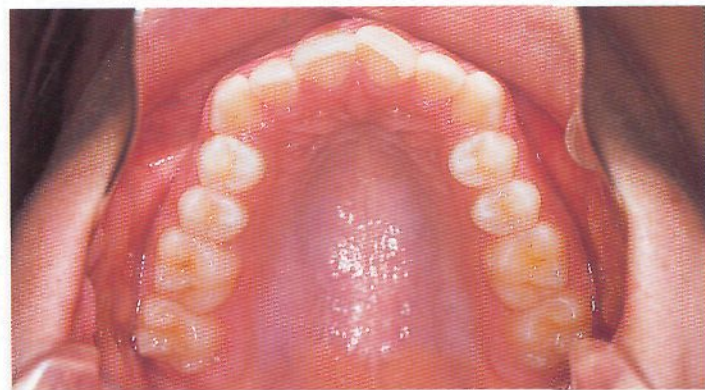


Fig. 8.70

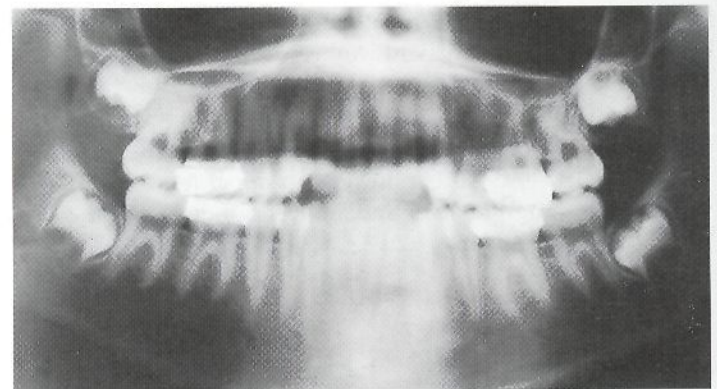


Fig. 8.71



Fig. 8.73

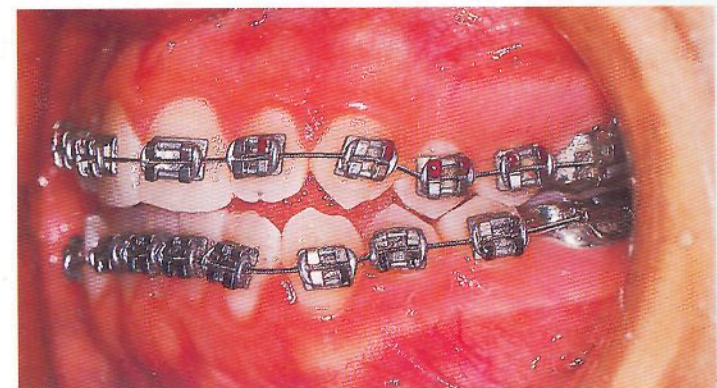


Fig. 8.74

After 1 month, upper and lower .019/.025 HANT wires were placed with Kobayashi ties on lower canines. The patient was asked to wear full-time Class III elastics (75 gm).

After 4 months of treatment, a lower .016 HANT wire was placed, and triangular elastics were used to close the anterior open bite.

After 7 months of treatment, a lower rectangular HANT wire was resumed, and the patient was asked to wear a cross elastic on the left side molars. Subsequently, upper and lower steel rectangular wires were used to correct the anterior torque, and the incisor relationship was overcorrected. Normal settling procedures (p. 294) were followed. An upper removable acrylic wraparound retainer and a lower bonded retainer were supplied.

Active treatment time was 18 months. The case is seen here after appliance removal.



Fig. 8.75

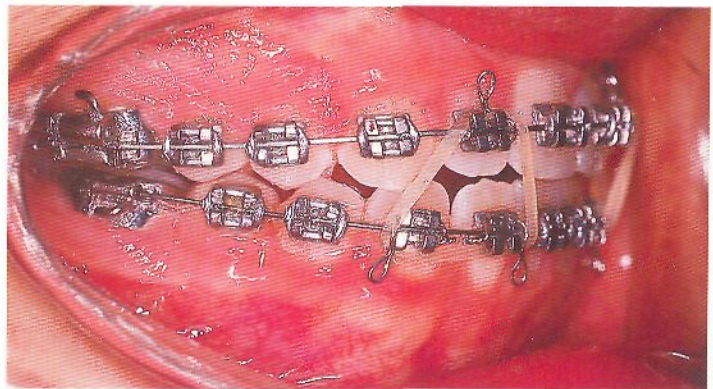


Fig. 8.78

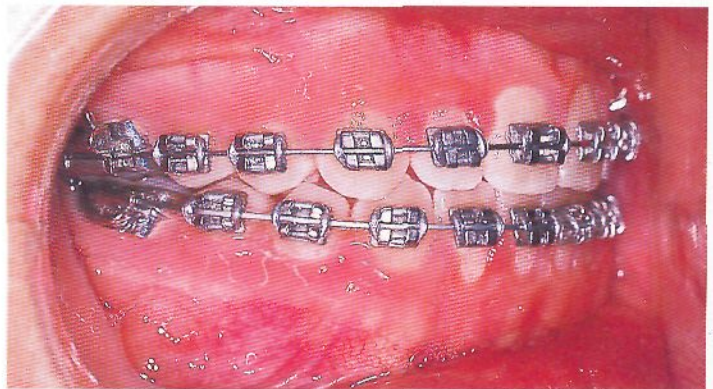


Fig. 8.81



Fig. 8.84



Fig. 8.76

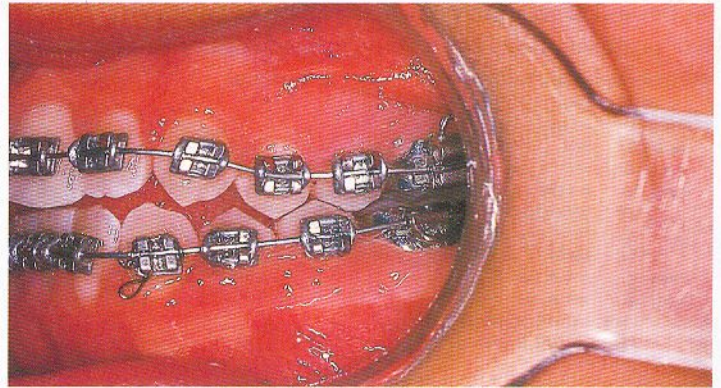


Fig. 8.77

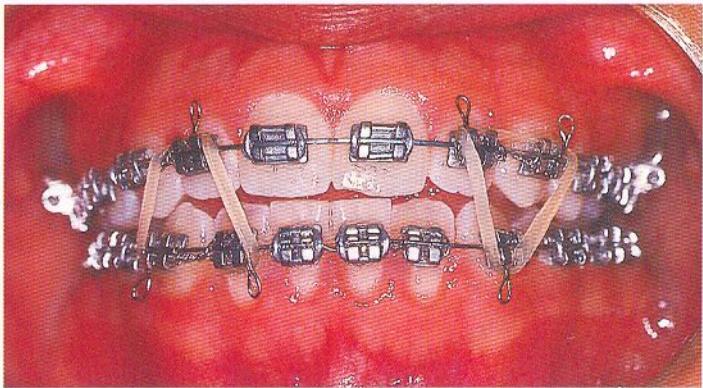


Fig. 8.79

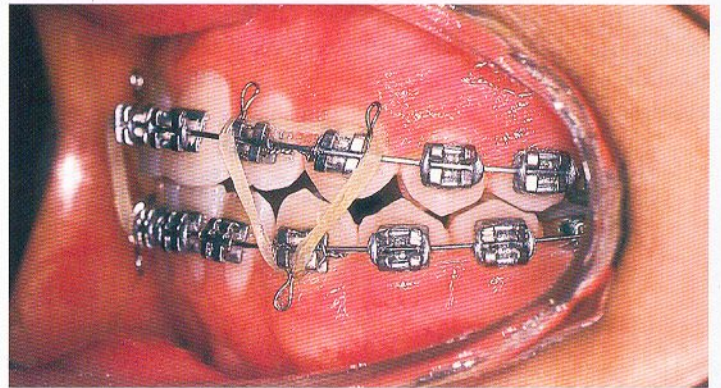


Fig. 8.80

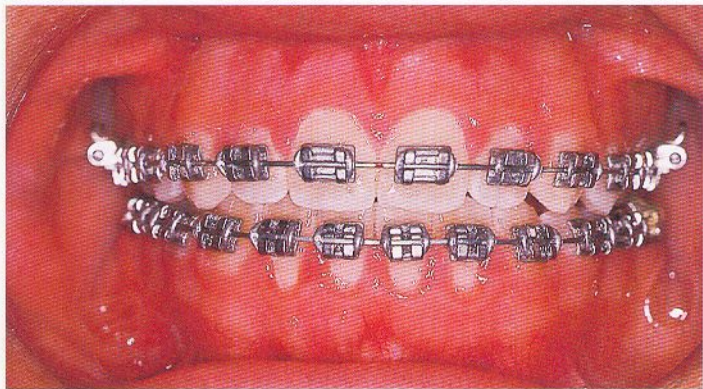


Fig. 8.82

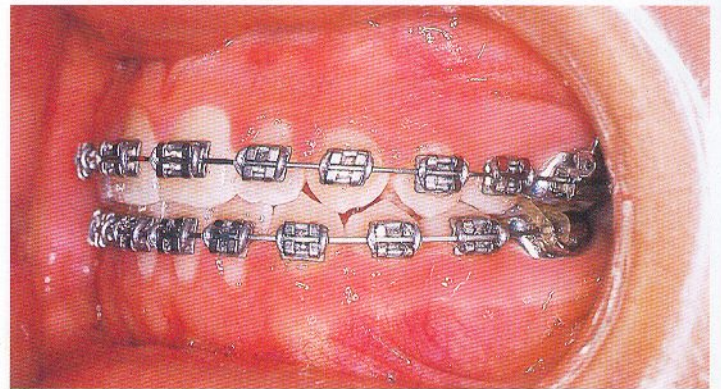


Fig. 8.83

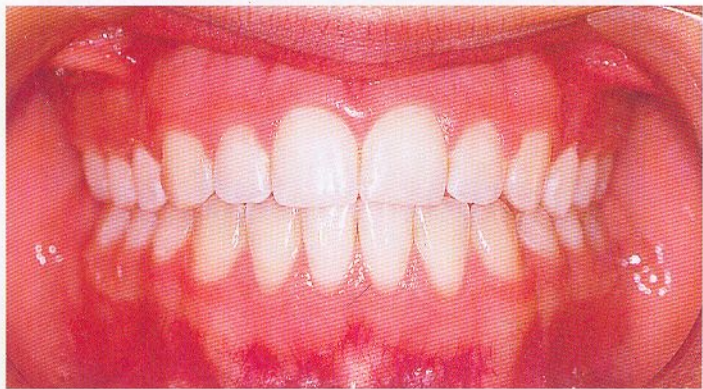


Fig. 8.85



Fig. 8.86

At the end of treatment, there was good facial balance. The A/P position of incisors was unchanged relative to APo, and torque measurements were close to normal.

Superimpositions suggest that some distal movement of molars occurred, and that there was typical counter-clockwise rotation of the occlusal plane in response to the Class III elastics.

Occlusal photographs and panoramic radiograph taken at the end of treatment.

Occlusal photographs taken 1 year after treatment and panoramic radiographs taken 7 months after treatment. Subsequently all third molars erupted into good position. This does not always happen, and third molar uprighting is needed in some cases. (Case DO, p. 215)



Fig. 8.87

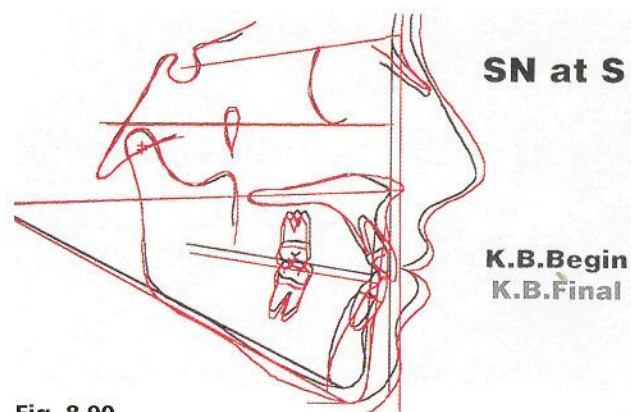


Fig. 8.90

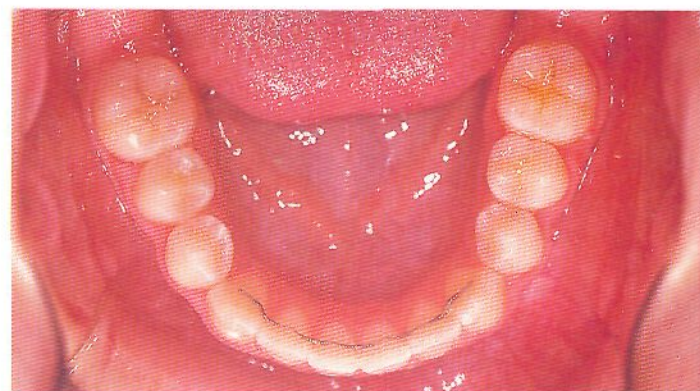


Fig. 8.93

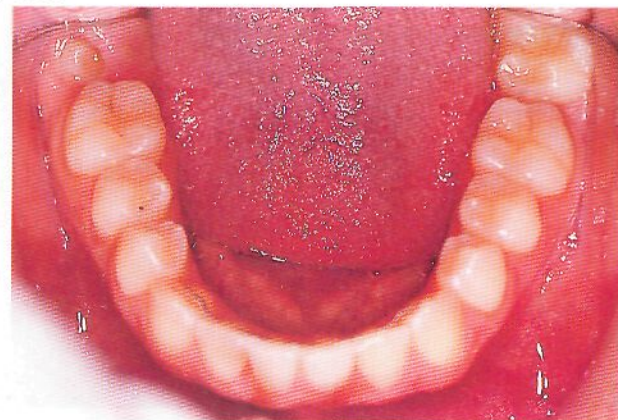


Fig. 8.96



Fig. 8.88

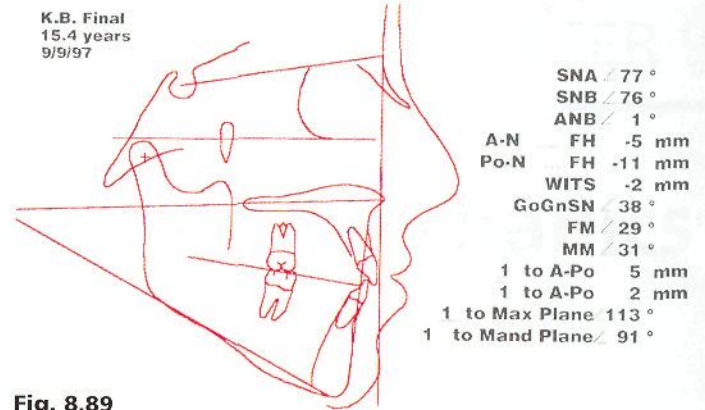


Fig. 8.89

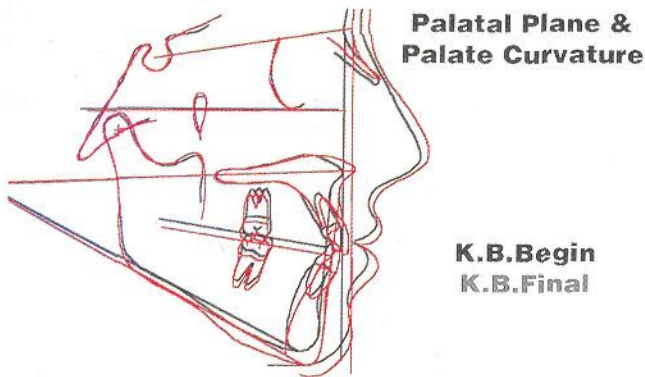


Fig. 8.91

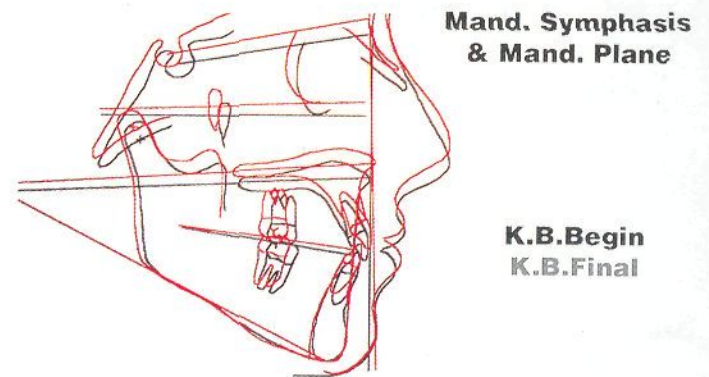


Fig. 8.92



Fig. 8.94

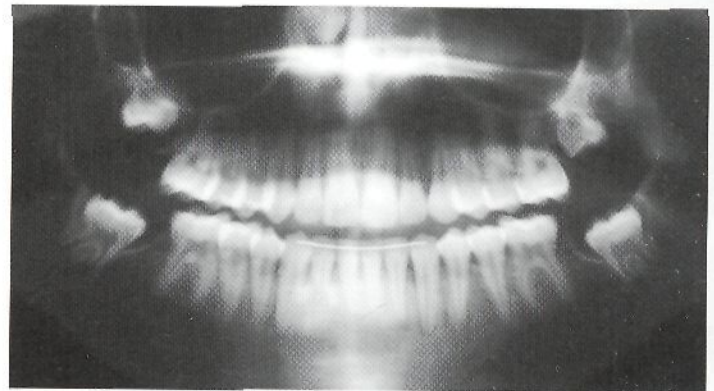


Fig. 8.95

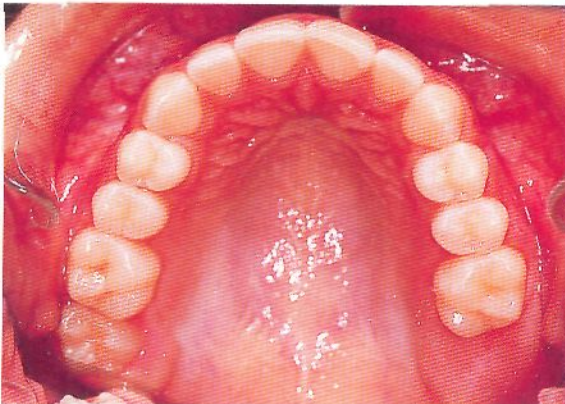


Fig. 8.97

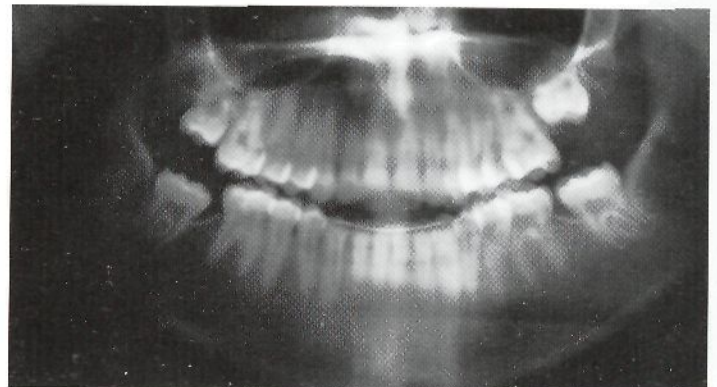


Fig. 8.98

Space closure and sliding mechanics

Introduction – the need for efficient space closure 250

Methods of space closure 252

Closing loop archwires 252

Sliding mechanics with heavy (ex-edgewise) forces 252

Elastic chain 254

Sliding mechanics with light forces 254

Alternative mechanics for spaces resistant to closure 258

Obstacles to space closure 259

Anchorage balance during space closure 260

Reciprocal space closure 260

Space closure in maximum anchorage cases – crowding 260

Space closure in maximum anchorage cases – protrusion 261

Space closure in minimum anchorage cases – 'burning anchorage' 262

Case NH An adult first premolar extraction case, with a mild Class III skeletal problem 264

Case MO'T A first premolar extraction case 272

INTRODUCTION – THE NEED FOR EFFICIENT SPACE CLOSURE

Although space closure is sometimes needed in non-extraction cases, the subject is generally discussed relative to premolar extraction cases. Space closure is carried out in the same manner in both groups, and although the subject of orthodontic extractions has been controversial in the past, it is now accepted that extraction of four premolars is beneficial in some cases. The 7 mm of space provided in each quadrant may be used to benefit the patient in one or more of the following ways:

- Relief of crowding, to achieve stable alignment of the dentition
- Retraction of upper anterior teeth to correct the overjet in Class II/1 cases
- Retraction of lower incisors to assist correction of Class III cases
- Retraction of upper and lower incisors to improve facial profile or occlusion in bimaxillary proclination cases
- Mesial movement of molars, increasing space for third molar eruption.

In maximum anchorage cases, most of the space will be used to relieve crowding (Fig. 9.1) or to retract incisors (Fig. 9.2).

However, in minimum anchorage cases, where crowding or protrusion is minimal, less than 7 mm of space in each quadrant will be needed for relief of crowding or incisor retraction. In these cases, there will be a need to close the residual spaces by mesial movement of first and second molars, providing more space for eruption of third molars (Fig. 9.3).

Reciprocal space closure of premolar space (Fig. 9.4) will be appropriate in many cases, especially where residual spaces are small. But in other cases it is necessary to vary the treatment mechanics and to control the anchorage balance, either to retract incisors (Fig. 9.5) or to mesialize molars (Fig. 9.6).

Consequently, in an efficient orthodontic practice, there is a need for a reliable method of space closure, which will allow control of anchorage balance.

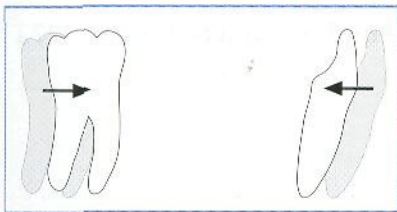


Fig. 9.4 Reciprocal space closure.

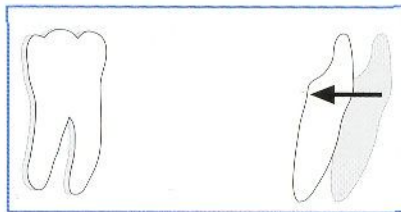


Fig. 9.5 Incisor retraction.

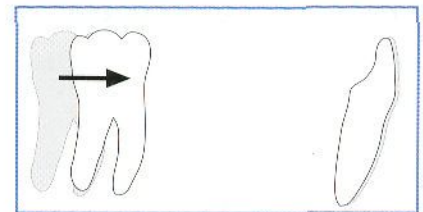


Fig. 9.6 Mesial molar movement.

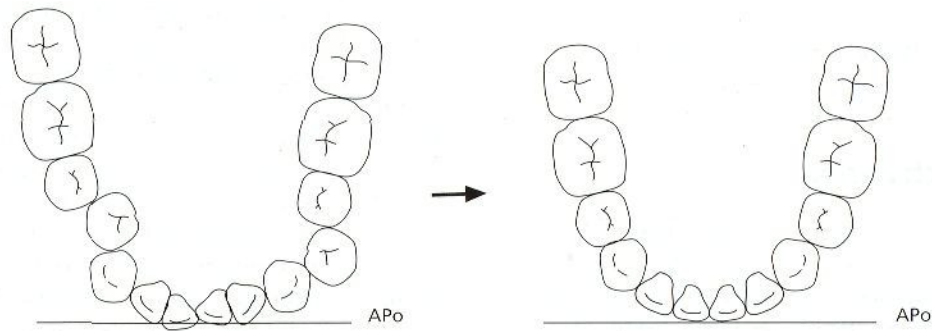


Fig. 9.1 Premolar extraction spaces may be used to relieve crowding and achieve stable alignment of the dentition.

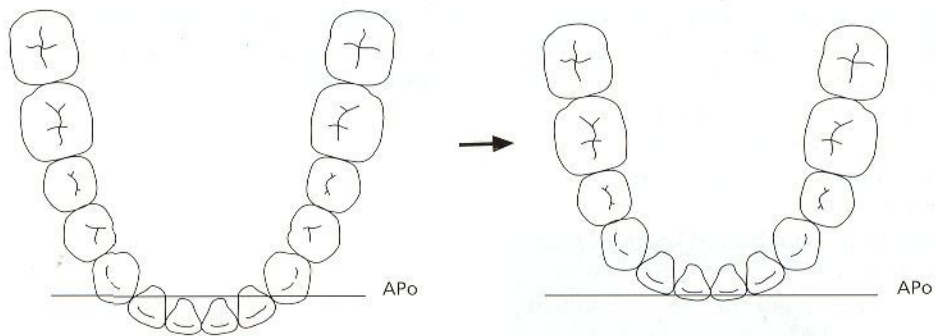


Fig. 9.2 Incisors and canines may be retracted into premolar extraction spaces, thereby improving the balance of the facial profile in cases with excessive protrusion.

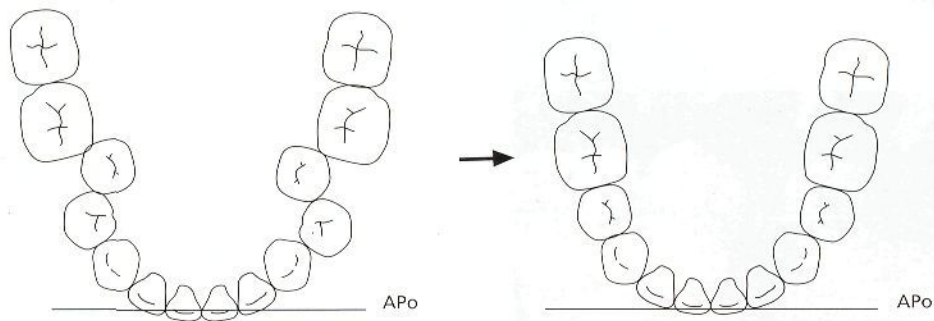


Fig. 9.3 Mesial movement of molars may be needed to close residual space in minimum anchorage cases. This will provide more space for eruption of third molars.

METHODS OF SPACE CLOSURE

- Closing loop archwires
- Sliding mechanics with heavy forces
- Elastic chain
- Sliding mechanics with light continuous forces (recommended).

Closing loop archwires

Edward Angle favored a non-extraction approach to all cases and space closure mechanics were not normally needed. Later, however, closing loop archwires became part of traditional edgewise mechanics, as described by Tweed.¹ Each rectangular steel wire typically had four loops – two omega loops and two closing (teardrop) loops – and had to be individually made for each patient. There was a limited range of action before the omega loop came into contact with the molar tube.

Closing loop archwires were flexible, because of the loops, but applied a heavy space closure force in the extraction sites. There was therefore a need for extra tip, rotation control, and torque control during space closure with these mechanics, and this was achieved by placing individual bends in the wire for each tooth. These bends could be selectively removed or reduced later in the treatment.

There were disadvantages to this method of space closure. A lot of wire bending time was needed, and the forces were heavy; sliding mechanics were poor, and the mechanism had only a short range of activation. Closing loop archwires (Fig. 9.7) are therefore not recommended for routine space closure with preadjusted brackets. Occasionally, they may be helpful in closing a small amount of residual space, especially in adults.

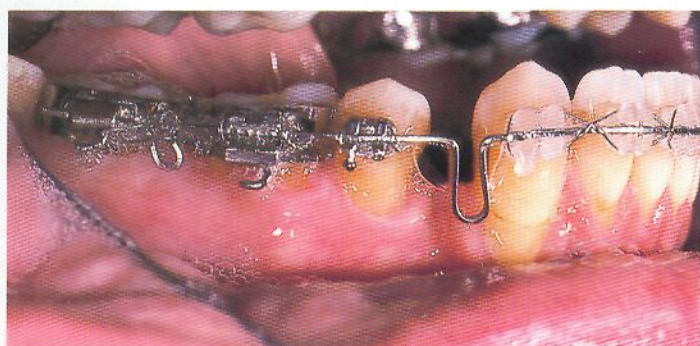


Fig. 9.7 Closing loop archwires were part of traditional edgewise treatment mechanics. They were individually made for each patient, and had a limited range of action before the omega loop came into contact with the molar tube.

Sliding mechanics with heavy (ex-edgewise) forces

A wide range of treatment mechanics was evaluated during the 1970s, in the early days with the preadjusted bracket system. Attempts were made to apply traditional edgewise force levels (500–600 gm) to the new brackets. It was found that heavy space closure forces (for example using steel Pletcher springs on .018/ .025 steel wires) caused unwanted tip, rotation, and torque changes (Figs 9.8–9.11).

When these heavy forces were used for space closure, there was therefore a need for extra tip, rotation control, and torque control. This additional control could be achieved by designing extra tip, rotation, and torque into the brackets. This was the background to the 'extraction series' or 'translation series' brackets developed by Andrews.² However, such brackets retained the extra features through to the end of treatment (unlike standard edgewise, where anchor bends, for example, could be adjusted in the final stages). Cases treated with extraction series brackets and heavy forces therefore placed heavier demands on anchorage early in the treatment, and often had over-corrected tooth positions at the end of treatment (Fig. 9.12).

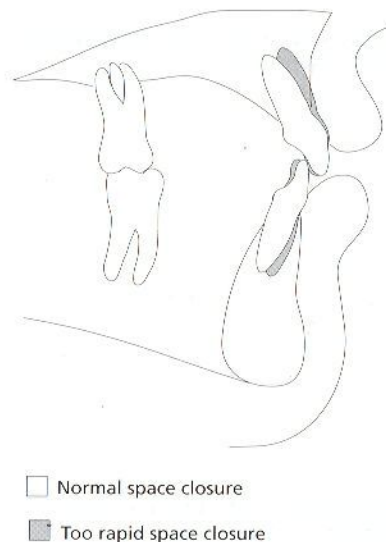


Fig. 9.8 Too rapid incisor retraction can leave the incisors with inadequate torque.

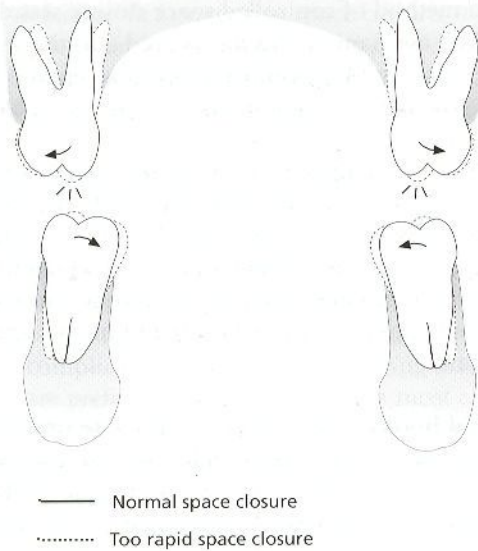


Fig. 9.9 Too rapid space closure also allows unfavorable torque effects on upper and lower molars. The movements shown are not favorable for proper functional chewing movements, and molars in this position require additional torque to reach ideal position.

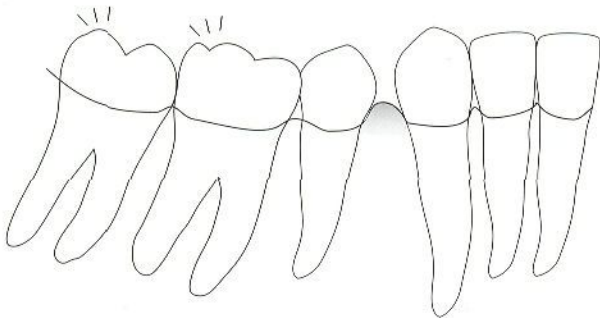


Fig. 9.11 Unwanted effects of over-rapid space closure include lower molar tipping, with extrusion of the distal cusps, especially in high-angle cases. Also, excessive soft tissue build-up can occur, which sometimes prevents proper space closure, or causes re-opening of extraction space.

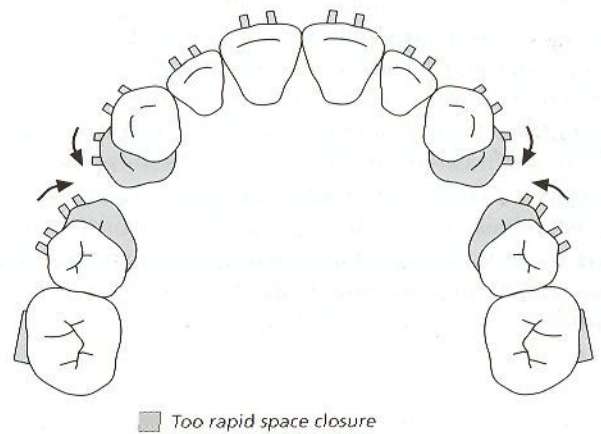


Fig. 9.10 In response to too rapid space closure, there is an increased tendency for rolling in of teeth adjacent to extraction sites.

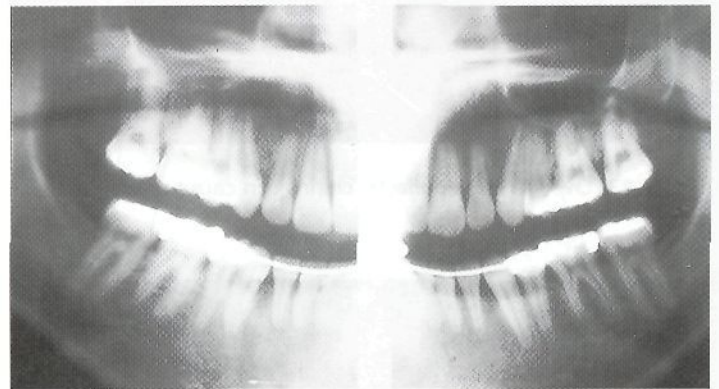


Fig. 9.12 This patient was treated using upper canine brackets with 11° of tip, leaving the upper canine roots in close proximity to the premolar roots.

Elastic chain

Elastic chain is not recommended for closure of large spaces, because of force level issues. For example, 'C-1' chains stretched from first molar to first molar, initially generate 400 gm of force in the upper arch and 350 gm of force in the lower arch. This places them in the force range just below closing loops and steel Pletcher coil springs. In a first premolar extraction case, for example, over-stretched chain links in the extraction sites (Fig. 9.13) will cause rotation of adjacent teeth. Under-stretched chain links in the extraction sites (Fig. 9.14) will not produce any space closure.

Elastic chain is useful for dealing with one or two minor spaces towards the end of treatment (p. 295) and light chain can be helpful in preventing spaces from opening late in the treatment, when finishing .014 wires are in place.



Fig. 9.13 Over-stretched elastic chains can cause unwanted rotations.

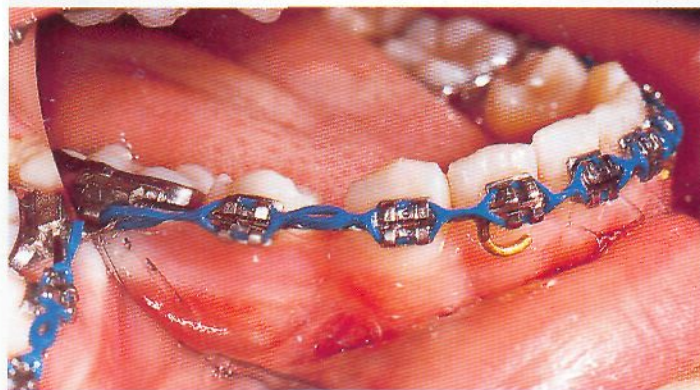


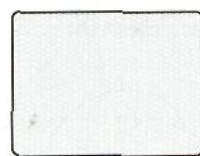
Fig. 9.14 Under-stretched elastic chains will not achieve space closure.

Sliding mechanics with light forces

In 1990, a method of controlled space closure was described³ using sliding mechanics. This has proved effective and reliable for many years, and has seen widespread acceptance by clinicians. The authors recommend the following technique:

- **Archwires.** Rectangular 019/.025 steel wires ('working wires') (Fig. 9.15) are recommended with the .022 slot, because this size of wire gives good overbite control while allowing free sliding through the buccal segments. Thinner wires tend to give less overbite and torque control. Thicker wires sometimes restrict free sliding of molars and premolars.
- **Soldered hooks.** The authors continue to prefer 0.7 soldered brass hooks. Soft stainless steel 0.6 soldered hooks can be a useful alternative, and some adult patients prefer the appearance of these. The most common hook positions are 36 mm or 38 mm (upper) and 26 mm (lower), measured along the line of the arch (Fig. 9.16). The authors find that the 26 mm lower hook position fits a high percentage of cases, but there is greater variability in hook positions in the upper arch, due to tooth size variation among upper lateral incisors. Therefore, a wider range of upper hook sizes needs to be stocked.

- **Passive tiebacks.** Before starting space closure, it is recommended that the rectangular steel .019/.025 wires be left in place for at least 1 month with passive tiebacks (Fig. 9.17). This allows time for torque changes to occur on individual teeth and for final leveling of the arches, so that sliding mechanics can proceed smoothly when active tiebacks are placed.
- **Active tiebacks using elastomeric modules.** In daily clinical practice, these are simple, economical, and reliable. Placement is not difficult and can be delegated routinely, with few complications. Active tiebacks using elastomeric modules are preferred for space closure in most cases, even though nickel-titanium springs have been shown to be more reliable and effective,⁴ as discussed below.



.019/.025

Fig. 9.15 Rectangular .019/.025 steel 'working' wires are recommended.

- **Force levels.** Elastic tiebacks were originally described³ using an elastomeric module, of the type used to hold archwires on to brackets, stretched to twice its normal size. This was found to give a force of 50–100 gm, if the module was pre-stretched or 'worked' before use. If used direct from the manufacturer, without pre-stretching, the force may be 200–300 gm greater.⁵ The force delivered by the elastic module varies with the type of module used, pre-stretching before use, and the amount of stretching when placed. It has been reported that different clinicians have successfully used different types of module, with different pre-stretching and different amounts of stretching when placed in the mouth.⁶ Despite these variations in technique and force levels, there is widespread acceptance that elastic tiebacks achieve good space closure. It therefore seems that

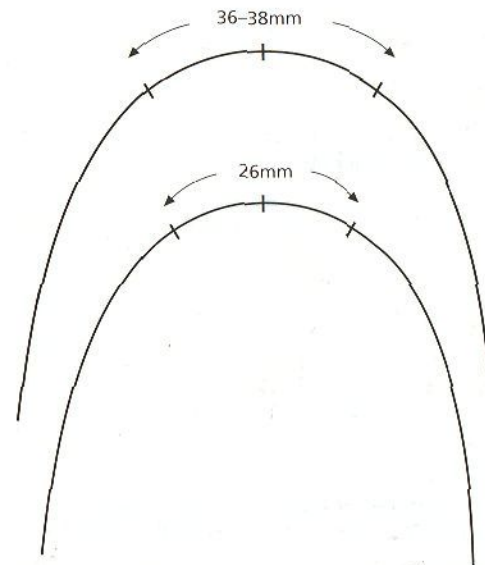


Fig. 9.16 The most commonly used hook positions.

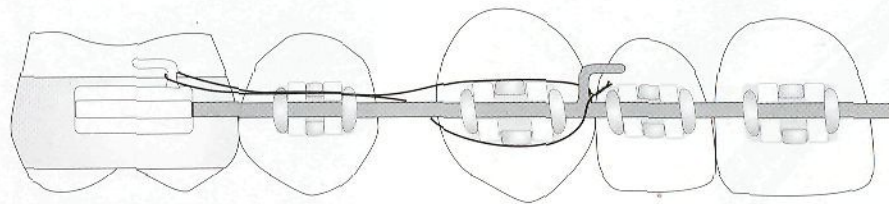


Fig. 9.17 Passive tiebacks are recommended at the time of placement of rectangular .019/.025 steel wires. These are used for at least 1 month to allow torque changes to occur on individual teeth. Later, active tiebacks are used for space closure.

precise force levels are not essential for day-to-day success, and that adequate space closure occurs in most cases, provided the general concept is followed.

- **Trampoline effect.** Clinical experience has shown that space closure can continue for several months in patients who have failed to present for normal adjustments, even when the elastomeric module is in poor condition and apparently delivering very little force. How can this consistent clinical experience be explained? One can speculate that there may be a 'trampoline effect' which occurs during mastication, and which can result in an intermittent pumping activation.
- **Type one active tieback (distal module).** The .019/.025 rectangular steel archwire is placed, with modules or wire ligatures on all brackets (Fig. 9.18). The elastomeric module is attached to the first or second molar hook. A .010 ligature is used, with one arm beneath the archwire (Fig. 9.19). This makes the active tieback more stable, and helps to keep the ligature wire away from the gingival tissues.
- **Type two active tieback (mesial module).** This follows the same principle as the type one, but the elastomeric module is attached to the soldered hook on the archwire. The .019/.025 rectangular steel archwire is placed with elastomeric modules or wire ligatures on all brackets,

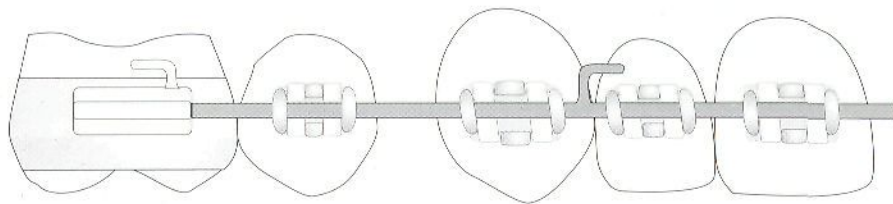


Fig. 9.18 Before placing the type one active tieback, the .019/.025 rectangular steel archwire is placed, with elastomeric modules or wire ligatures on all brackets.

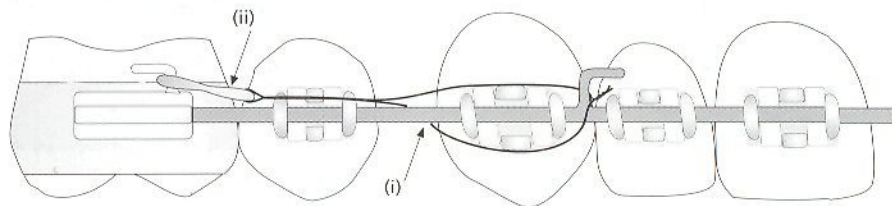


Fig. 9.19 The completed type one active tieback. It is helpful to carry one arm of the ligature wire (i) under the archwire. An elastomeric module is stretched to twice its unstretched size (ii).

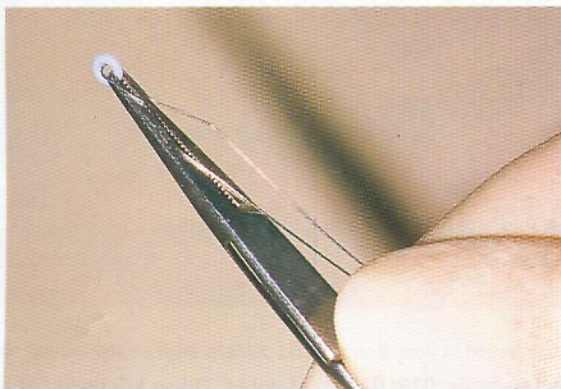


Fig. 9.20 A type one active tieback just before placement.

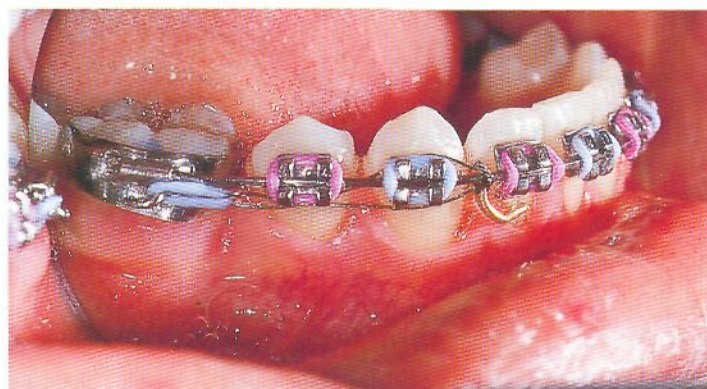


Fig. 9.21 A lower type one active tieback. This shows minimal activation of the elastomeric, and slightly more stretching could be used.

except the premolar brackets (Fig. 9.22). A .010 wire ligature is attached to the first or second molar hook, with several twists in the wire, and then attached to an elastomeric module on the archwire hook. Finally, a normal module is placed on the premolar brackets to cover the tieback wire and the archwire (Figs 9.23 & 9.24). With the type one and type two tiebacks, the elastomeric modules are normally stretched to twice their resting size for activation. If oral hygiene is good, adjustment visits may be less frequent; they may be re-activated after 4 to 6 weeks, and remain in place for two visits. If oral hygiene is

poor, the elastomeric modules may deteriorate and require replacement at every visit. In some cases, in the final stages of space closure, it may be helpful to use two modules, or to augment the tieback with a 10- or 12-link elastomeric chain from molar to molar.

- **Active tiebacks using a nickel-titanium coil spring.** Nickel-titanium springs can be used, instead of elastomeric modules, if large spaces need to be closed, or if there are infrequent adjustment opportunities (Fig. 9.25). Recent work by Samuels et al⁷ has recommended that the optimal

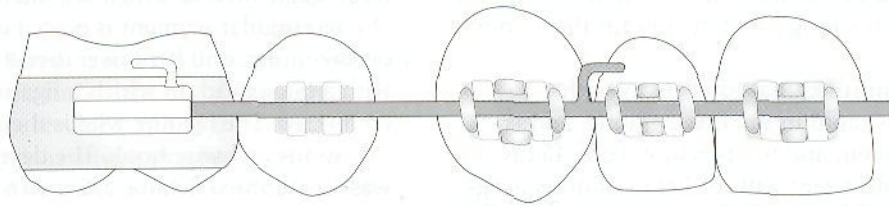


Fig. 9.22 Before placing the type two active tieback, the .019/.025 rectangular steel archwire is placed, with elastomeric modules or wire ligatures on all brackets, except the premolar brackets.

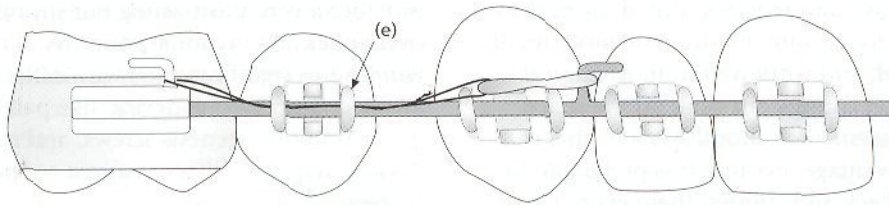


Fig. 9.23 The completed type two active tieback. This follows the same principle as the type one active tieback, but the module is attached anteriorly. The final elastomeric module (e) is placed after the archwire and the tieback. It stabilizes the tieback wire and helps to direct it away from the soft tissues.

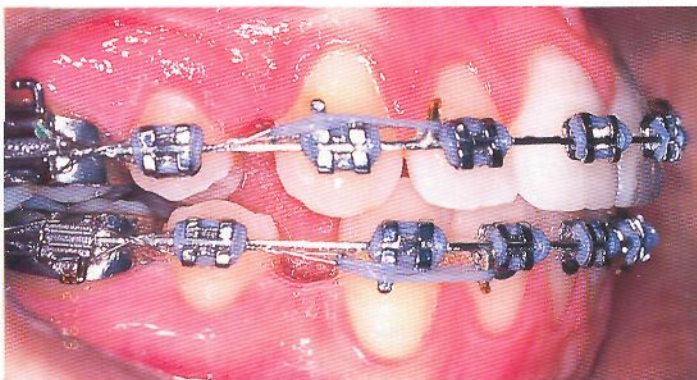


Fig. 9.24 Type two active tiebacks (mesial modules) in upper and lower arches. The elastomerics are stretched maximally in this photograph – ideally, in most treatments, slightly less stretching is appropriate. For final space closure, it is sometimes helpful to place two elastomeric modules. See also Figure 9.98, p. 275.

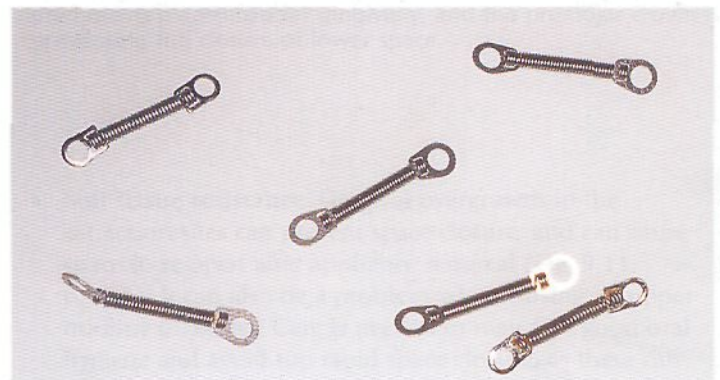


Fig. 9.25 Although nickel-titanium springs produce more consistent space closure than elastomeric modules, the authors consider the ease and simplicity of the modules make these preferable in most treatments. Nickel-titanium springs may be useful in cases where a large amount of space closure is required, or where there are infrequent adjustment opportunities.

force for space closure is 150 gm when using nickel-titanium coil springs as the force for space closure. The 150 gm springs were found to be more effective than 100 gm springs, but no more effective than 200 gm springs. This work confirmed their earlier findings⁴ that nickel-titanium springs produce more consistent space closure than elastomeric modules. It suggests the use of light closed coil nickel-titanium springs (344–150 and 346–150 3M Unitek) to give a force of 150 gm. Springs should not be expanded beyond the manufacturers recommendations (22 mm for the 9 mm springs, and 36 mm for the 12 mm springs).

Nattrass et al⁶ confirmed that force decay with elastomeric chains is rapid in the first 24 hours and is affected by environment and temperature. Force decay did not occur to the same extent with nickel-titanium springs. Although the research evidence favors the use of nickel-titanium coil springs for more rapid space closure, the authors continue to use elastomeric modules for space closure in most cases. If spaces are closed too rapidly, incisor torque can be lost, and requires several months to regain at the end of space closure. Elastomeric modules are easy to use, economical, and work well in most clinical situations. Although coil springs can close all the space without requiring replacement at monthly visits, this is largely a theoretical advantage, because it is preferable to take out the wires to check and shorten them every 1 or 2 months during space closure.

Alternative mechanics for spaces resistant to closure

In a few cases, it may be found that spaces are slow or difficult to close with the normal mechanics. If no obstacles to space closure are evident (see below), alternative mechanics may be considered. Tiebacks with two modules may help, or a looped archwire can be made. A useful alternative in difficult space-closure situations is the Hycon[®] device from Edenta. This has been used successfully by one of the authors for 4 years in selected cases.

The device consists of a centimeter segment of 21 × 25 rectangular wire, to which is soldered a 7 mm screw device. The rectangular segment is placed in the double or triple tube on the molar, and bent over distally. The screw is provided with a large head, to which a ligature wire can be loosely connected. The ligature wire is then extended forwards and tied to the archwire hook. The developer of the Hycon[®] device was Dr Winfried Schütz, a German orthodontist, and he suggests that a small screwdriver be used twice per week to turn the screw one full turn (1/8 mm) in a clockwise direction. Thus, approximately 1 mm of space closure is accomplished per month (Case NH, p. 268). This device provides a very short-acting but strong force that essentially overcomes any frictional concerns. If overdone, however, it will lead to significant archwire deflection, which should be avoided. The Hycon[®] device, like palatal expanders, distraction osteogenesis screws, and some molar distalizing devices, requires diligent patient cooperation to ensure success.

Obstacles to space closure

In almost all cases, space closure is easy and proceeds uneventfully. Only rarely are problems encountered. If it appears that space is not closing as it should (about 1 mm per month typically), the spaces should be carefully measured at successive visits. If they are not reducing, or if wire is not appearing gradually from the distal of the molar tube, then possible obstacles should be evaluated before resorting to different mechanics:

- **Inadequate leveling.** The working rectangular wires need to be in place for at least 1 month with passive ties (p. 255), to ensure proper leveling and freedom from posterior torque pressure. Also, it is important not to attempt overbite correction using reverse curve in the lower archwire at the same time as attempting space closure. Overbite control should be achieved before space closure.
- **Damaged brackets.** Lower first molar brackets can be damaged and partly closed down by excessive biting forces. As a short-term measure, the wire may be thinned in that area, but it is better to replace the molar attachment. The use of first molar non-convertible tubes is recommended, as these are not susceptible to damage in the same way as first molar convertible tubes, and they have other advantages (pp 53 & 54).
- **Incorrect force levels.** Forces above the recommended levels can cause tipping and friction, and thus prevent space closure. Inadequate force may sometimes be a cause of slow- or non-space closure in adult treatment. Force levels need to be in balance with archwire size and stiffness. If they are not in balance, archwire deflection and unwanted friction can occur. It has been shown that archwire deflection causes friction^{8,9}. Also, recent research in Japan¹⁰ has measured the amount of deflection of rectangular archwires in response to typical space closure force. It has been shown that on average 47% more deflection occurs with a .016/.022 wire compared with a .019/.025 wire (Fig. 9.26).
- **Interference from opposing teeth** (Fig. 9.27). This can prevent lower space closure, and it is necessary to carefully check the occlusion. In the past this was often related to vertical bracket-positioning errors in the upper arch. The use of gauges has reduced these errors, and interference is seldom an obstacle now.

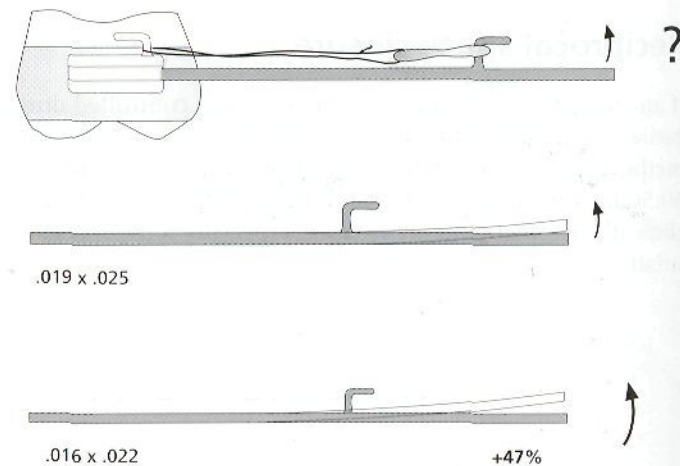


Fig. 9.26 Force levels need to be in balance during space closure and sliding mechanics. A .019/.025 steel rectangular wire is recommended in the .022 slot.

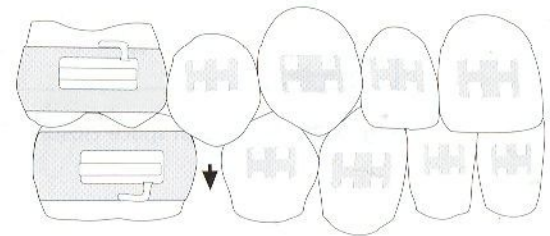


Fig. 9.27 Space closure can be prevented by interference from opposing teeth. In this illustration, the bracket on the upper premolar is placed too far gingivally, and the premolar crown is preventing full closure of lower space.

- **Soft tissue resistance.** Gingival overgrowth in the extraction sites can prevent space closure, and can cause space to re-open after appliance removal (Fig. 9.11, p. 253). It can also be a problem when closing an upper midline diastema. Care is needed to maintain good oral hygiene and avoid too rapid space closure, as these can contribute to local gingival overgrowth. In a few cases, local surgery to soft tissue may be indicated.

ANCHORAGE BALANCE DURING SPACE CLOSURE

Reciprocal space closure

If anchorage has been properly planned and controlled during earlier stages of treatment, reciprocal space closure can be the method of choice in many cases. Theoretically, this leads to a 50:50 movement of incisors and molars (Fig. 9.28), which is clinically acceptable in many cases, especially if the spaces are small.

Space closure in maximum anchorage cases – crowding

Most of the premolar extraction space is used to relieve crowding in these cases. This requires careful anchorage control early in treatment (Case NH, p. 266), but then the space closure stage is normally minimal, because the available space has mainly been used to relieve crowding.

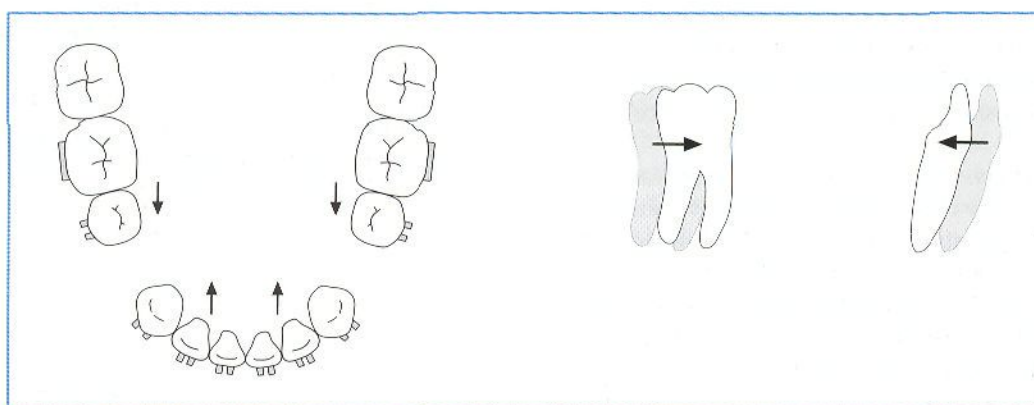


Fig. 9.28 Reciprocal space closure. This is the method of choice in many cases.

Space closure in maximum anchorage cases – protrusion

Space closure is important in these cases. Good anchorage control is needed at the space closure stage in order to achieve incisor retraction into the available extraction space. First premolars are normally chosen for extraction. Second molars are included in the set-up if possible. In this way, six anterior teeth are balanced against six larger posterior teeth, giving a theoretical advantage in anchorage balance (Fig. 9.29). Palatal bars and lingual arches may be used during the alignment stage, to restrict mesial movement of molars, and the palatal bar may be continued into the space closure stage. If patient cooperation is available, a headgear may also be considered, sometimes with Class III elastics (Fig. 9.30).

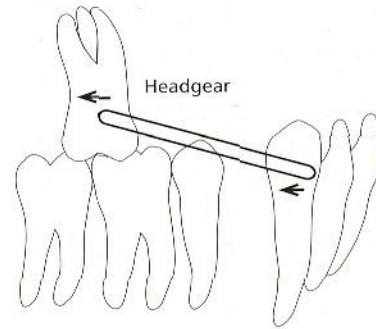


Fig. 9.30 In maximum anchorage cases, lower arch retraction may be supported by Class III elastics to upper molars, worn simultaneously with a headgear.

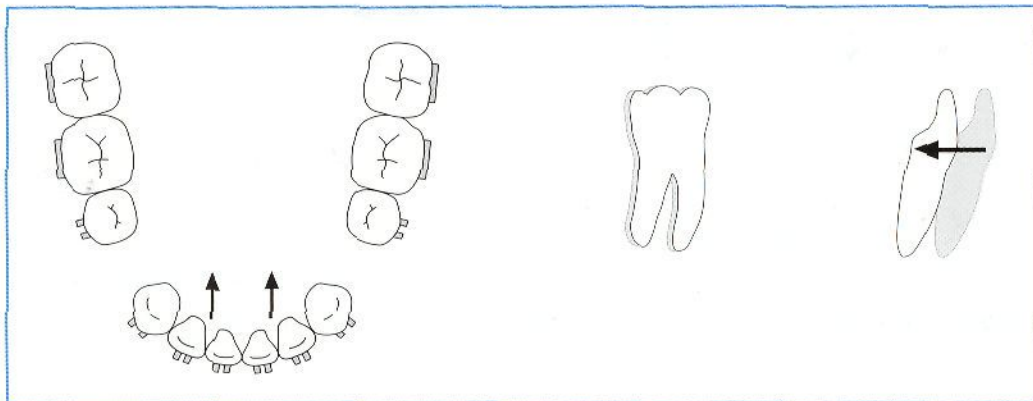


Fig. 9.29 Space closure in a maximum anchorage case with protrusion.

Space closure in minimum anchorage cases – 'burning anchorage'

These are cases where there is only mild crowding or protrusion, but where extraction of premolars is needed to achieve proper treatment goals. It is necessary to close remaining spaces mainly by mesial movement of molars, thereby increasing available space for third molars and protecting facial profile. Second premolars may be chosen for extraction in this type of case, and second molars are normally not banded or bracketed. The thinking behind this approach is based on the mathematical balance of two molar teeth against eight anterior teeth during sliding mechanics. Logically, mainly mesial molar movement could be expected (Figs 9.31 & 9.32).

In this type of case, it is correct to commence treatment soon after extraction of second premolars, to avoid the

possibility of the alveolar bone becoming narrow. Light Class II elastics (100 gm), worn just at night, can support mesial movement of the lower molars during sliding mechanics. The torque of $+17^\circ$ for upper central incisors and $+10^\circ$ for upper lateral incisors seems to be clinically helpful in maintaining the A/P position of the upper labial segment, against the 10- to 12-hour Class II elastic force. The molars receive a 24-hour mesializing force, which is greater in the lower arch, due to the light Class II elastics.

If careful treatment mechanics are followed after extraction of second premolars, it is possible to close space mainly by mesial movement of first and second molars, increasing available space for third molars, and maintaining the position of the lower incisors in the facial profile.

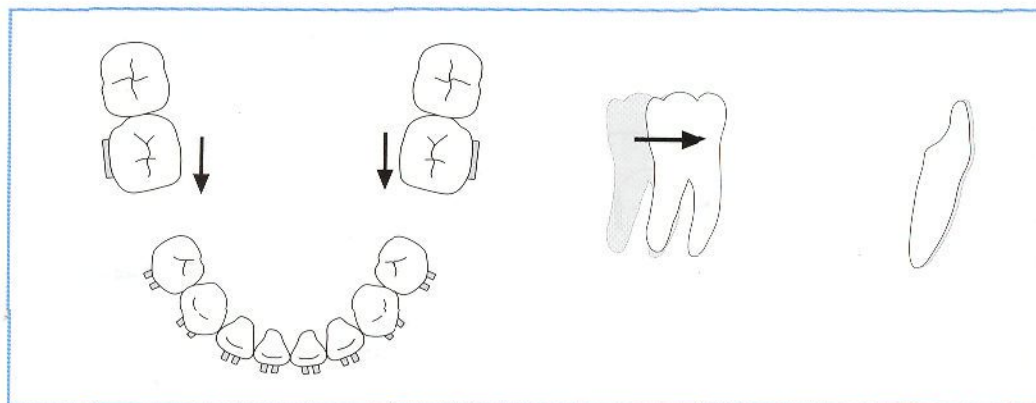


Fig. 9.31 Space closure in a minimum anchorage case – 'burning anchorage'.

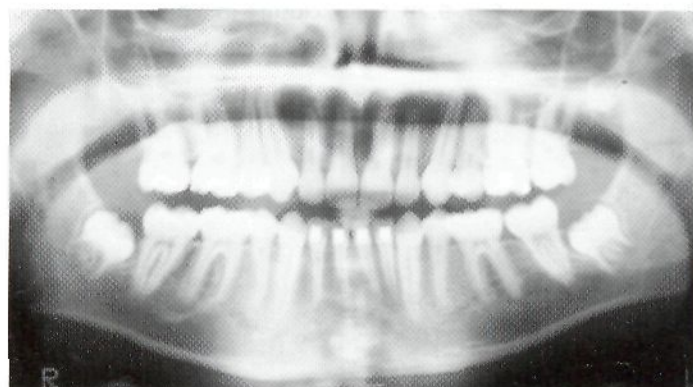


Fig. 9.32 'Before' and 'after' radiographs of a second premolar extraction case. Mesial movement of lower first molars has created space for second and third molars.

REFERENCES

- 1 Tweed, C H 1966 Clinical orthodontics. Mosby, St Louis
- 2 The 'A' Company Straight-Wire Appliance. An eight page descriptive brochure. 'A' Company, San Diego, CA, USA
- 3 Bennett J C, McLaughlin R P 1990 Controlled space closure with a preadjusted appliance system. *Journal of Clinical Orthodontics* 24:251-260
- 4 Samuels R H, Rudge S J, Mair L H 1993 A comparison of the rate of space closure using a nickel-titanium spring and an elastic module: a clinical study. *American Journal of Orthodontics and Dentofacial Orthopedics* 103:464-467
- 5 Natrass C, Ireland A J, Sherriff M 1997 An investigation into the placement of force delivery systems and the initial forces applied by clinicians during space closure. *British Journal of Orthodontics* 24:127-131
- 6 Natrass C, Ireland A J, Sherriff M 1998 The effect of environmental factors on elastomeric chain and nickel titanium coil springs. *European Journal of Orthodontics* 20:169-176
- 7 Samuels R H, Rudge S J, Mair L H 1998 A clinical study of space closure with nickel-titanium closed coil springs and an elastic module. *American Journal of Orthodontics and Dentofacial Orthopedics* 114:73-79
- 8 Pizzoni L, Ravnholt G, Melsen B 1998 Frictional forces related to self-ligating brackets. *European Journal of Orthodontics* 20:283-291
- 9 O'Reilly D, Dowling P A, Lagerstrom L, Swartz M L, 1999 An ex vivo Investigation into the effect of bracket displacement on the resistance to sliding. *British Journal of Orthodontics* 26:219-227
- 10 Ouchi K, Koga M, Watanabe K, Issiki Y, Kawada E 2001 The effects of retraction forces applied to the anterior segment on orthodontic arch wires – changes in wire deflection with wire size. Presented to southern California component of Edward H Angle Society. In press.

CASE NH

A 30-year-old male patient with severe anterior crowding on mild Class II dental bases (ANB 5°). He had Class I buccal segments, and third molars had been previously extracted.

There was a high-angle pattern (MM angle 35°). Lower arch form was checked with transparent arch form cards, and assessed as approximately ovoid.

The upper right central incisor was recorded at 12 mm to APo line and lower left central incisor at 5 mm to APo line. It was decided that the treatment goal would be to retract and align incisors to a planned incisor position (PIP) of approximately 7 mm to APo in the upper and 3 mm to APo in the lower.

Treatment mechanics were required to align upper incisors approximately to the starting position of the upper left central incisor, or a little more distally. In the lower arch, the objective was to align the lower incisors to the starting position of the lower right central incisor. It is desirable to treat as many cases as possible without extractions, but in this case there was a need to make space available for lower incisor alignment and retraction. Sufficient space could not be obtained from expansion or from enamel reduction. A decision was therefore made to extract all first premolars, and to treat this high-angle case as a maximum anchorage case, using an upper palatal bar and a lower lingual arch to support tooth movements during leveling and aligning stages.

Bendbacks were used to ensure that the ends of the archwire were comfortable in the molar area, and to help control mesial movement of the anterior teeth. (Bendbacks and lacebacks are normally continued throughout tooth leveling and aligning, until the rectangular steel archwire stage, in most cases.) Upper and lower ovoid .016 HANT wires were placed. Standard .022 metal brackets were used for optimal control, and bands were placed on all molars and premolars. The instanding lower incisors were not bracketed at this stage, because no space was available to position them in the line of the arch. Rubber sleeve was used for patient comfort meantime.



Fig. 9.33



Fig. 9.36

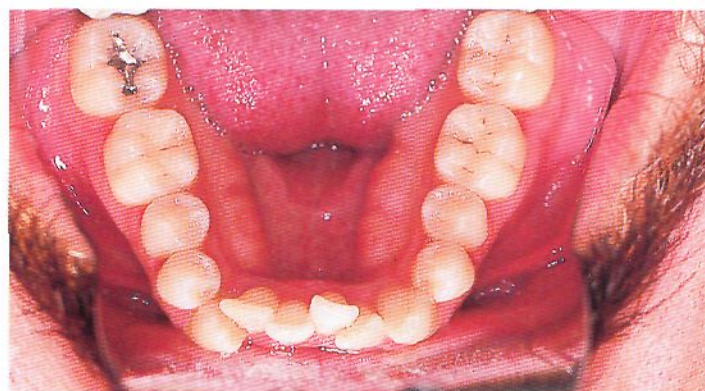


Fig. 9.39

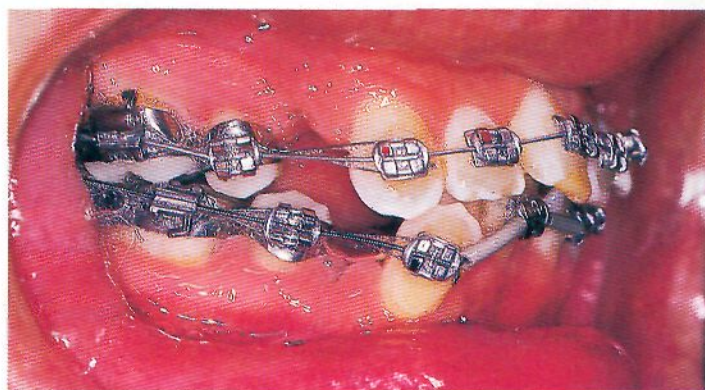


Fig. 9.42



Fig. 9.34

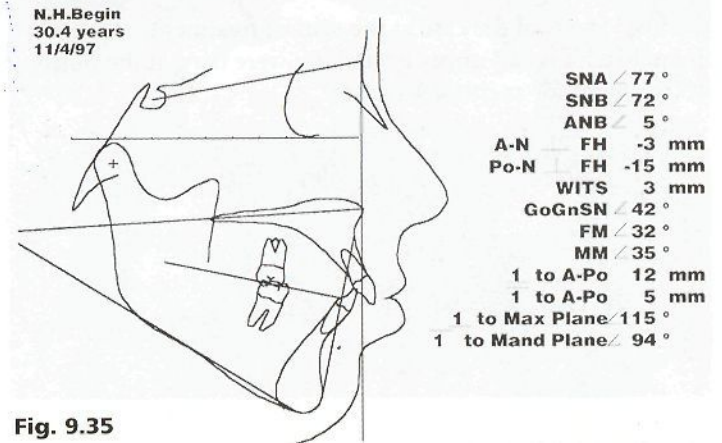


Fig. 9.35



Fig. 9.37



Fig. 9.38

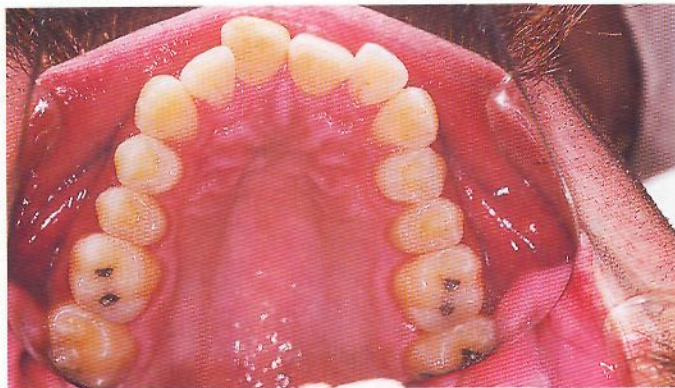


Fig. 9.40

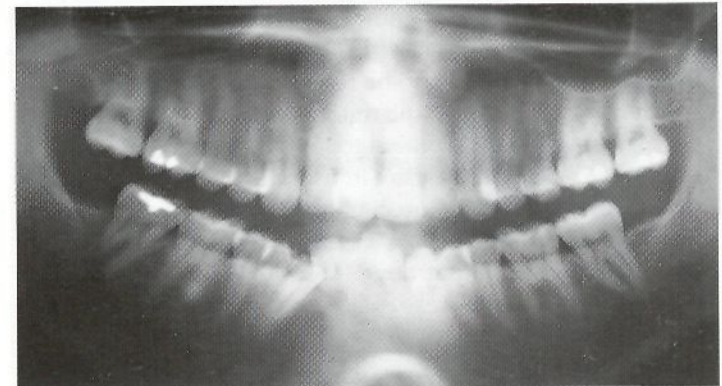


Fig. 9.41



Fig. 9.43

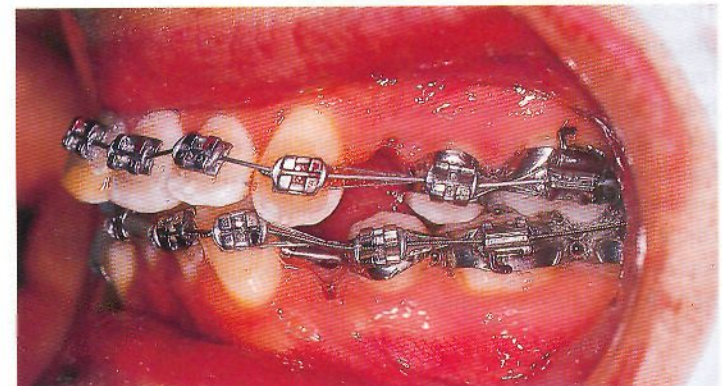


Fig. 9.44

Occlusal views of the case at the start of treatment. A lower lingual arch and an upper palatal bar were used at the outset of treatment for anchorage control.

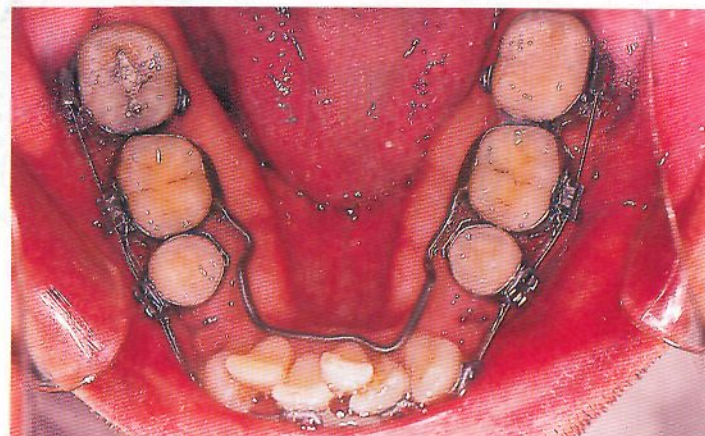


Fig. 9.45

Sequential views at early adjustment visits. At the first adjustment visit, the archwires were removed. The lower was checked, and the ends were re-flamed to re-soften them for new bendbacks. Upper and lower lacebacks were slightly tightened, to remove the 1 mm or so of slack which typically develops between adjustments in the early stages of treatment. An upper .019/.025 HANT wire was placed with bendbacks. The ends of the HANT wire were flamed and quenched before placement.

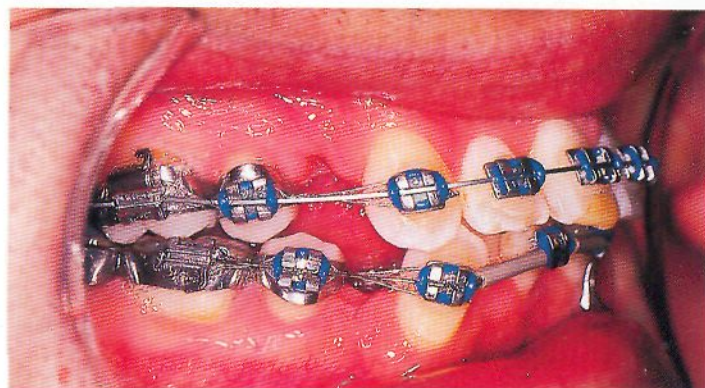


Fig. 9.48

At this stage, the case set-up can be clearly seen. As the upper incisors start to level, a 0.5 mm vertical adjustment to the upper right central incisor bracket can be seen (Fig. 9.52). This tooth was eventually to be restored and the slight extrusion was to facilitate the restorative procedure. Double upper molar tubes were placed to allow headgear support.

Normal canine brackets are in use with -7° upper and -6° lower torque. Consideration could be given to using 0° torque brackets in this type of case to assist in keeping the canine roots in cancellous bone. At subsequent visits, the lower .016 HANT wire was replaced with a .016 round steel wire and open coil springs to recreate space for lower incisors. Brackets adjacent to the open coil were tied with wire ties to prevent rotations.



Fig. 9.51

The case after 9 months of treatment. Upper lacebacks were discontinued and the upper rectangular HANT wire was replaced with a steel .019/.025 rectangular wire with soldered hooks and passive tiebacks. Enough space had been created for alignment of the instanding lower incisors, and these were bracketed. A lower .016 HANT ovoid archwire was used with lacebacks and bendbacks to start moving them into the line of the arch. It is not correct to attempt this before enough space has been created, as there is a risk of proclination and then a need for torque correction later.

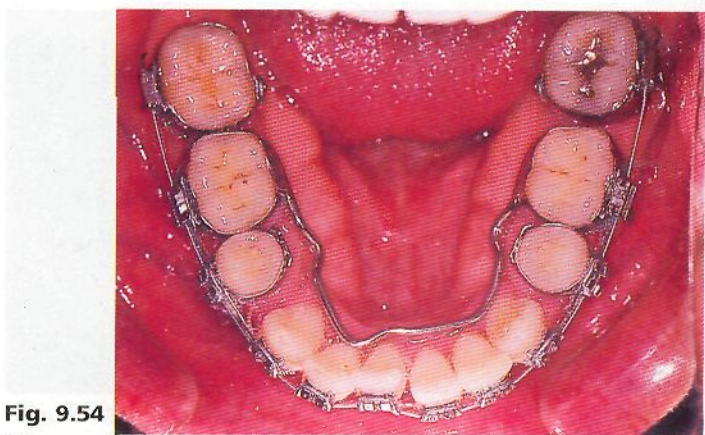


Fig. 9.54

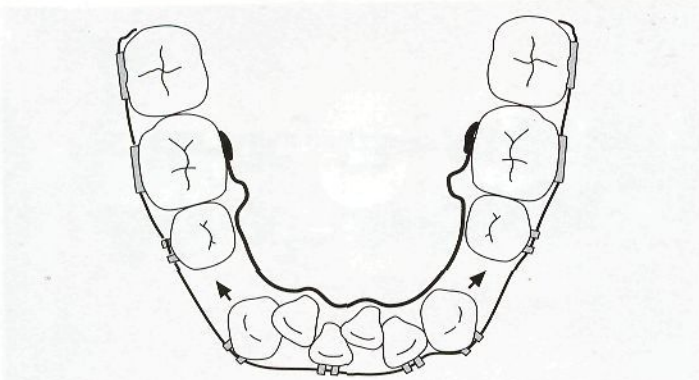


Fig. 9.46

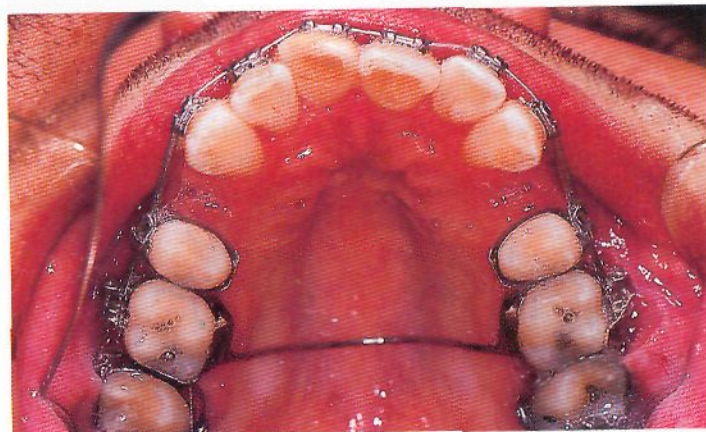


Fig. 9.47

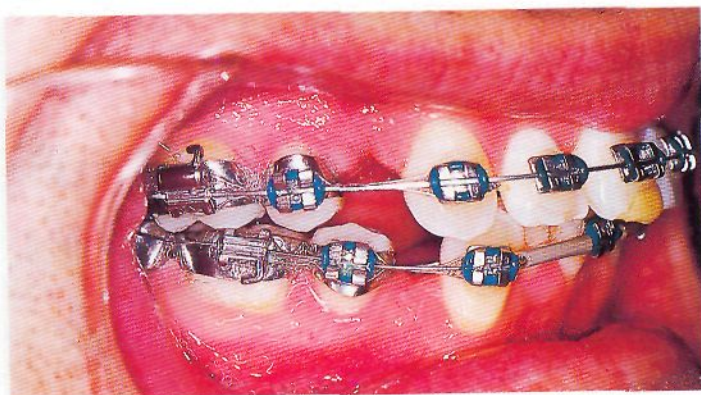


Fig. 9.49

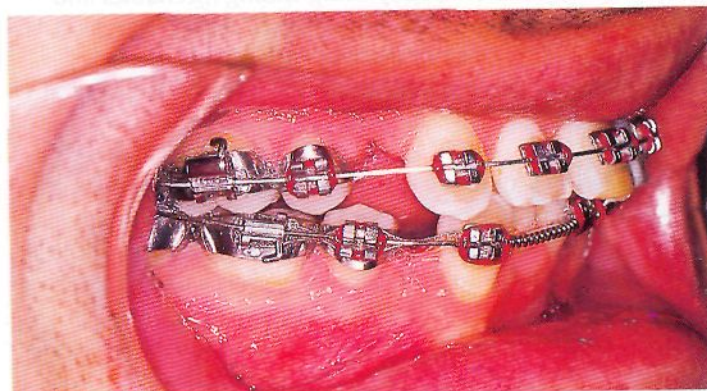


Fig. 9.50

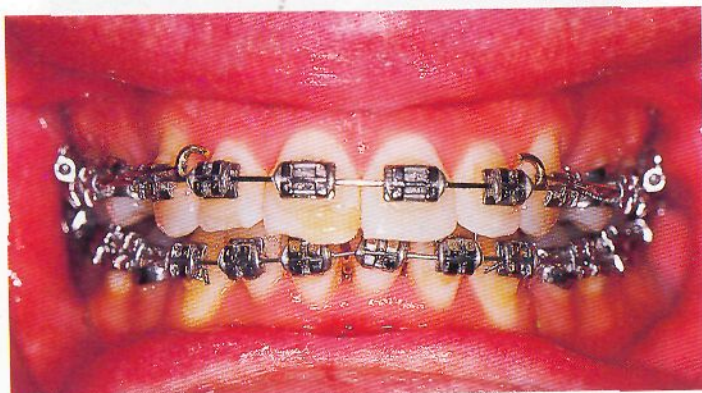


Fig. 9.52

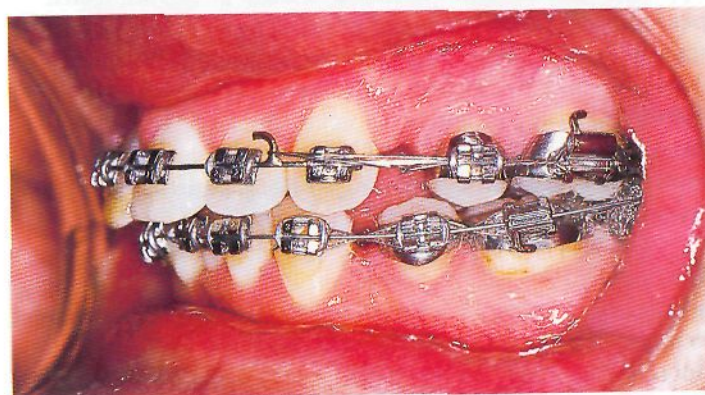


Fig. 9.53

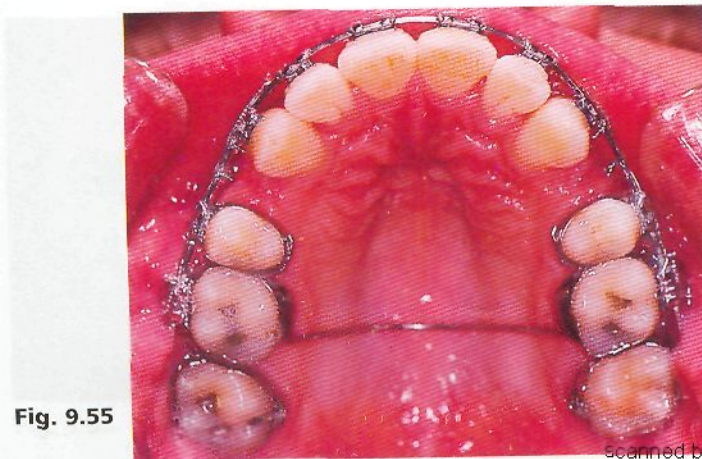


Fig. 9.55

Sequential views of the case after 10 months (Fig. 9.56), 13 months (Fig. 9.57), and 18 months (Fig. 9.58).

At the 7-month adjustment visit, a rectangular .019/.025 HANT lower wire (ovoid shape) had been placed, and at the 10-month adjustment visit, a rectangular .019/.025 steel lower wire (ovoid shape) was possible, with soldered hooks and passive tiebacks. At this stage, consideration was given to producing an individualized arch form (IAF) for this patient, but it was felt that the normal ovoid form was very close to the starting lower arch, and could therefore be used. Normal space closure was carried out with active tiebacks, but difficulty was experienced in closing the upper right premolar space. This is unusual. In almost all treatment of children, the spaces will close uneventfully using sliding mechanics and active tiebacks. In a few adult treatments, it may be found that spaces are slow or difficult to close with the normal mechanics, and there may be a need to use a rectangular wire with space-closing loops or a Hycon® device.

Sequential views of the right side showing space closure with the Hycon® device. No obstacles to space closure were evident, and alternative mechanics such as tiebacks with two modules, or a looped archwire were considered. A decision was made to use the Hycon® device from Edenta. This has been used successfully by one of the authors for 4 years in selected cases.

Sequential occlusal views showing space closure.

Approximately 1 mm of space closure can be accomplished per month. This device provides a very short-acting but strong force that essentially overcomes any frictional concerns. If overdone, however, it will lead to significant archwire deflection, which should be avoided. The Hycon® device, like palatal expanders, distraction osteogenesis screws, and some molar distalizing devices, requires diligent patient cooperation to ensure success.

The final settling stage of treatment, after 20 months. Finishing and detailing was not a separate and lengthy stage of mechanics in this case; as a result of good early treatment management, only careful settling was needed before proceeding into retention. A .016 round HANT wire was used in the lower arch, with ovoid arch form. In the upper arch, a .014 round sectional wire was placed from lateral incisor to lateral incisor. Teeth had been extracted, and therefore figure-8 ligature wires were placed across the extraction sites to hold them closed.

The .014 settling wires were accompanied by the use of light vertical triangular elastics and good settling occurred. In cases with accurate bracket placement, few elastics need to be used in this way. It was decided to keep all bands and brackets on the teeth during settling, so that if unwanted changes occurred, these could be corrected. The patient was seen at approximately 2-week intervals during the settling phase. Elastics were worn full time for the first 2 weeks, then at night for a period of 2 weeks.



Fig. 9.56

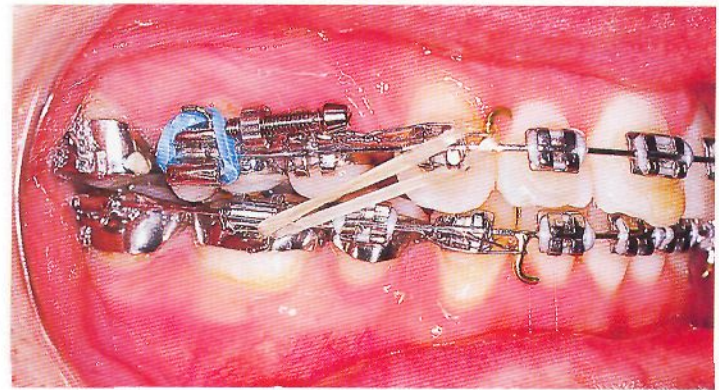


Fig. 9.59

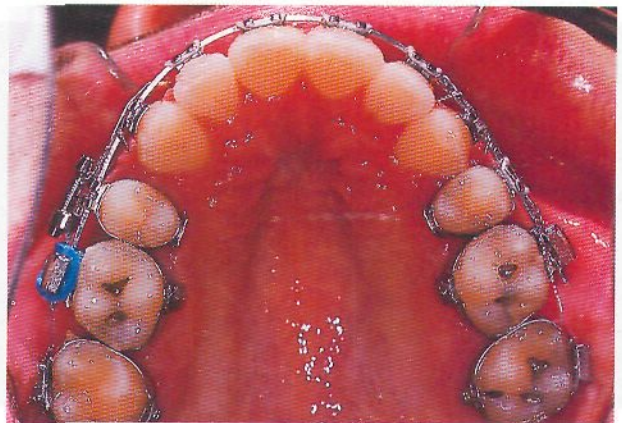


Fig. 9.62



Fig. 9.65

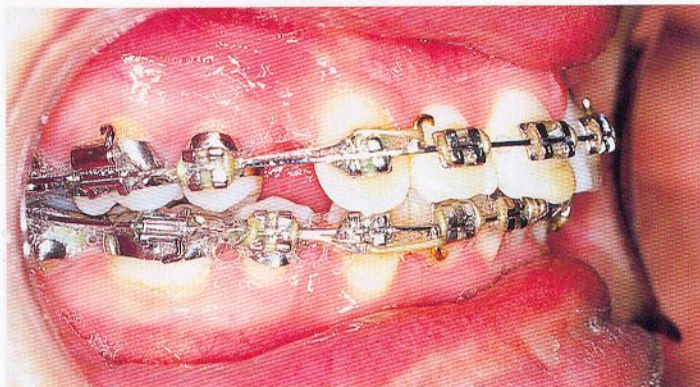


Fig. 9.57



Fig. 9.58

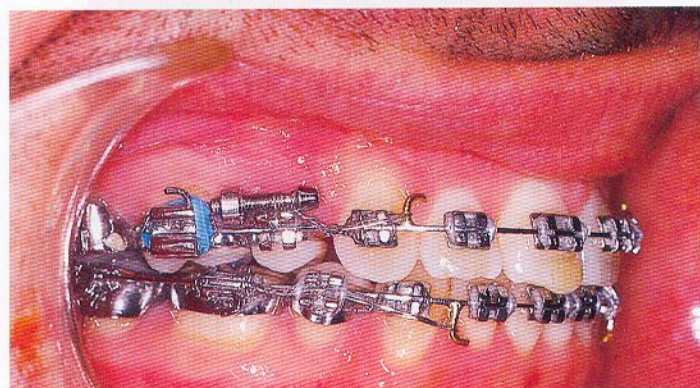


Fig. 9.60



Fig. 9.61

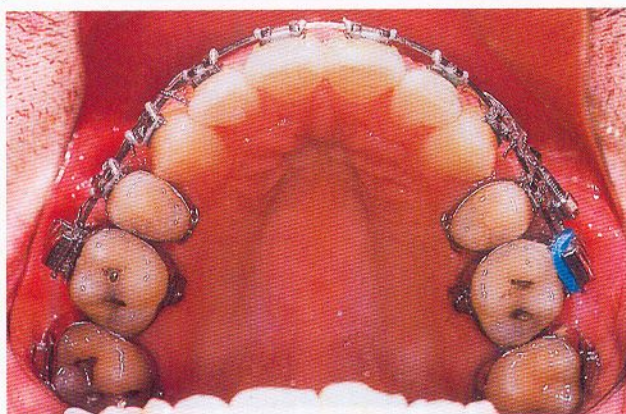


Fig. 9.63

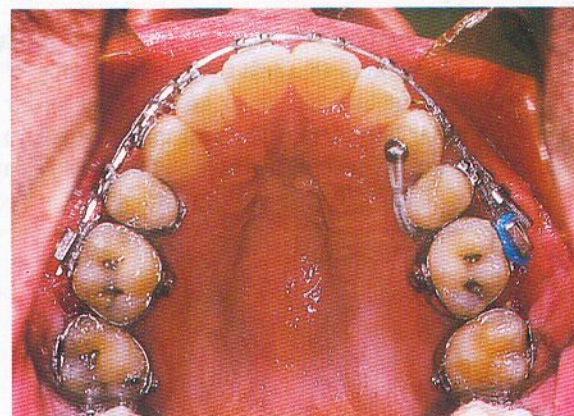


Fig. 9.64



Fig. 9.66



Fig. 9.67

The case after appliance removal. A lower bonded retainer was placed from second premolar to second premolar, to stabilize the lower anterior alignment and to prevent premolar space opening. It was recommended that the lower bonded retainer should be left in place indefinitely.



Fig. 9.68

A lower canine-to-canine lingual bonded retainer is placed for almost all the authors' patients at the end of treatment, and in first premolar extraction cases this is normally extended on to the mesial fossae of the second premolars, as in this case. The multistrand wire may be .015 or .019, and it is bonded with a very careful technique, using Transbond LR™. An upper vacuum-formed retainer was fitted, after adjustment to the restoration on the upper right central incisor. In the upper arch, the majority of relapse is likely to occur within the first 6 months, and the patient was therefore asked to wear the removable retainer full time, or as often as possible for several months.

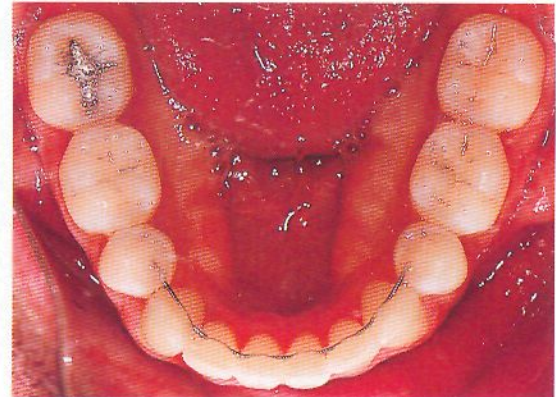
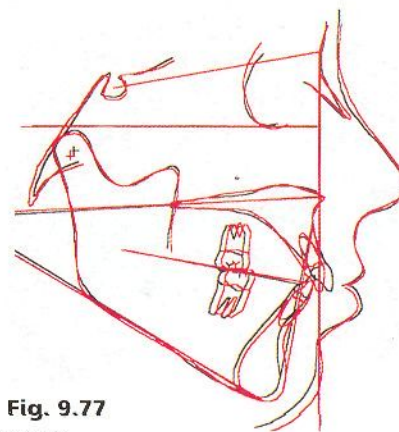


Fig. 9.71

Some band space is present mesial to upper second molars. This is a recurring problem in adult treatment. During finishing a tube can be bonded on to each second molar after removal of all molar bands. Elastic chain may be used to close band space on the rectangular wire, with incisor, canine and premolar teeth still carrying bonded brackets.



Fig. 9.74



SN at S

**N.H.Begin
N.H.Final**

Fig. 9.77



Fig. 9.69



Fig. 9.70

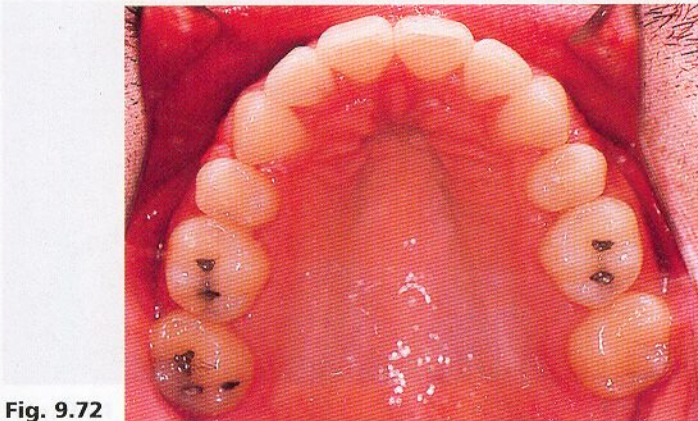


Fig. 9.72

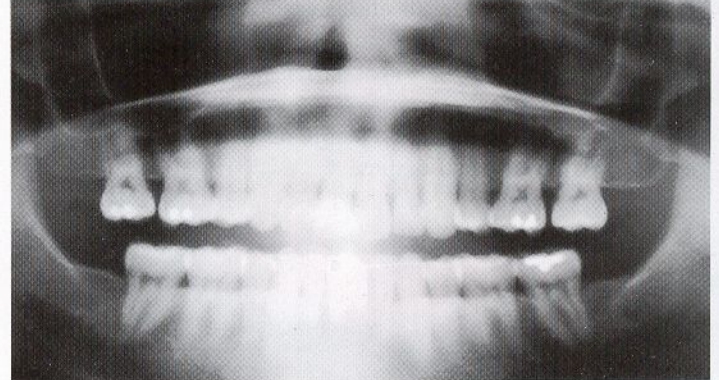


Fig. 9.73



Fig. 9.75

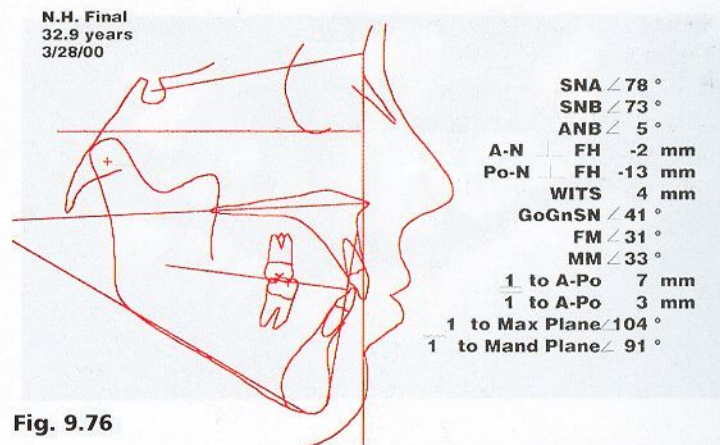


Fig. 9.76

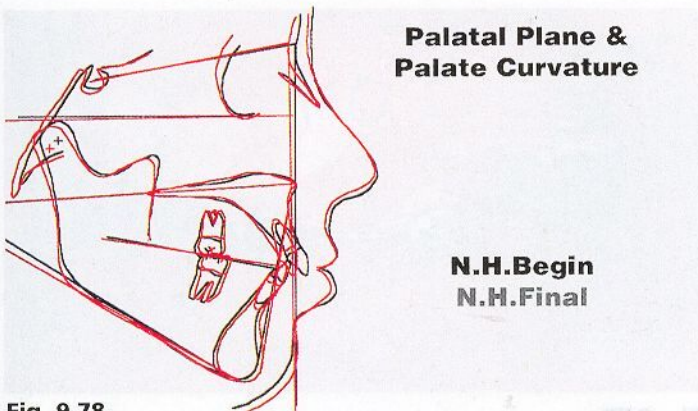


Fig. 9.78

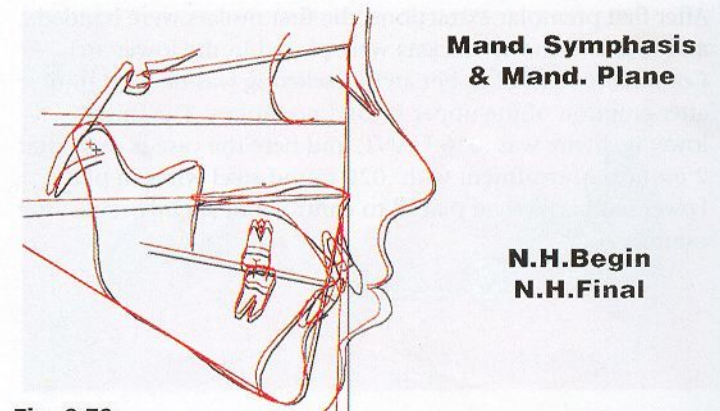


Fig. 9.79

CASE MO'T

A female first premolar extraction case, aged 11.6 years at the start of treatment, with Class II skeletal bases (ANB 7°) on an average angle pattern (MM 28°).

Dentally, there was anterior and posterior crowding with a lack of space for permanent canines. There was upper and lower incisor crowding with rotations. Archform was assessed as ovoid. It was felt that four first premolars should be extracted in order to achieve a stable result with good profile and healthy periodontal tissues.

After first premolar extractions, the first molars were banded, and standard metal brackets were placed in the lower arch. Commencement of upper arch bracketing was delayed until after eruption of the upper second premolars. The initial lower archwire was .016 HANT, and here the case is seen after 2 months of treatment with .020 round steel wires in place. Lower lacebacks were placed to control and slightly retract the canines.



Fig. 9.80



Fig. 9.83



Fig. 9.86

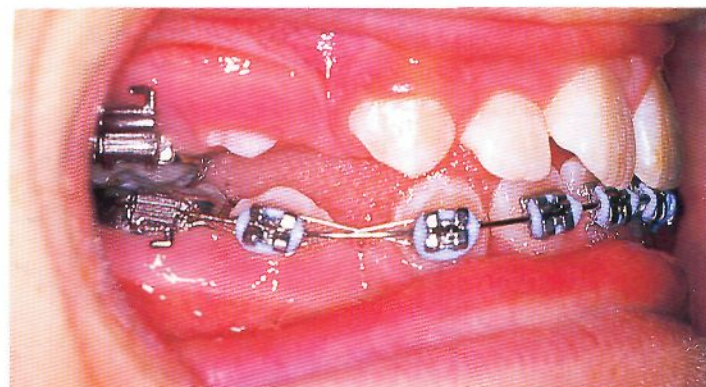


Fig. 9.89



Fig. 9.81

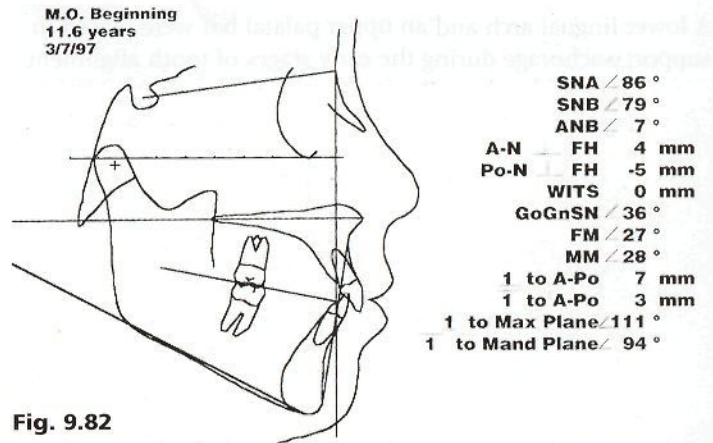


Fig. 9.82



Fig. 9.84



Fig. 9.85

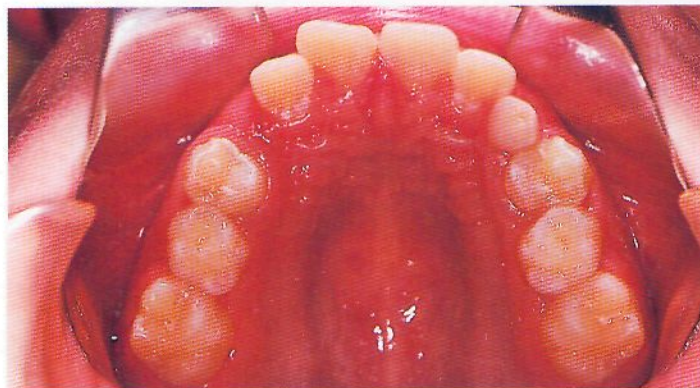


Fig. 9.87



Fig. 9.88

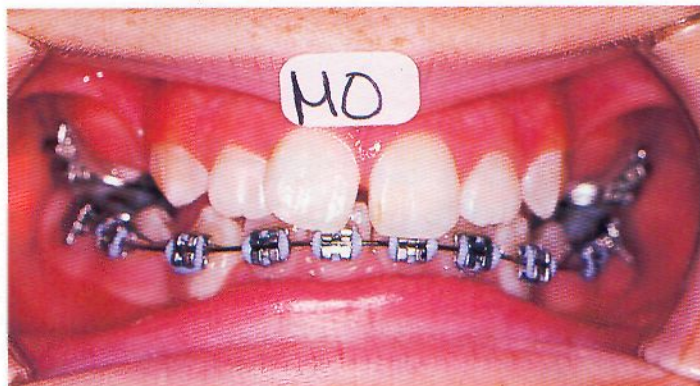


Fig. 9.90

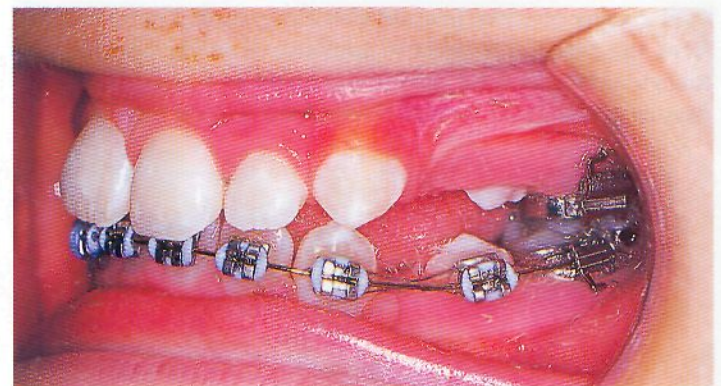


Fig. 9.91

A lower lingual arch and an upper palatal bar were placed to support anchorage during the early stages of tooth alignment.

When upper second premolars were close to full eruption, the six upper anterior teeth were bracketed and a .016 HANT wire was placed with passive coil springs to protect the long buccal spans of the archwire. Lower lacebacks were discontinued at this stage, as the canines were beginning to move away from the lateral incisors.

Sequential view of the right side of the treatment after 7 months, 11 months, and 15 months of treatment. At 7 months, upper and lower rectangular HANT wires are in place, and the upper canines have retracted a little away from the lateral incisors, as the lower canines have moved distally. This is acceptable during tooth leveling and aligning, and provides a small amount of additional anchorage. Subsequently, upper and lower steel rectangular wires were placed, with light Class II elastics during space closure. Passive tiebacks were placed to maintain the space closure.

After 2 years of active treatment, settling was commenced. Here, the case is seen prior to appliance removal. Light triangular elastics were used in the molar and premolar regions and the patient was checked at 2-weekly intervals.

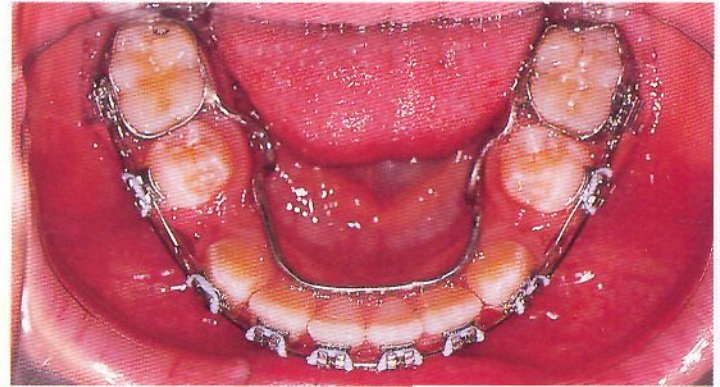


Fig. 9.92

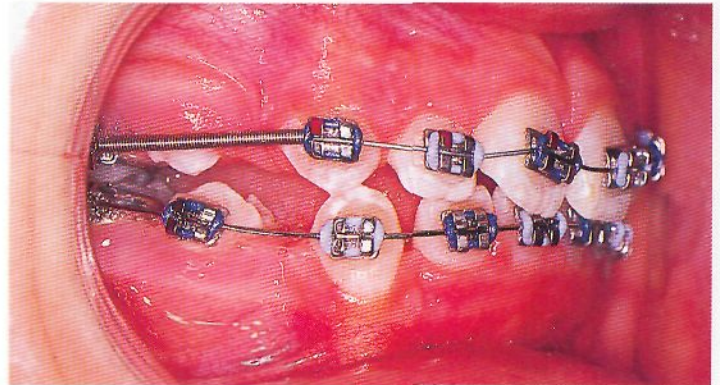


Fig. 9.94

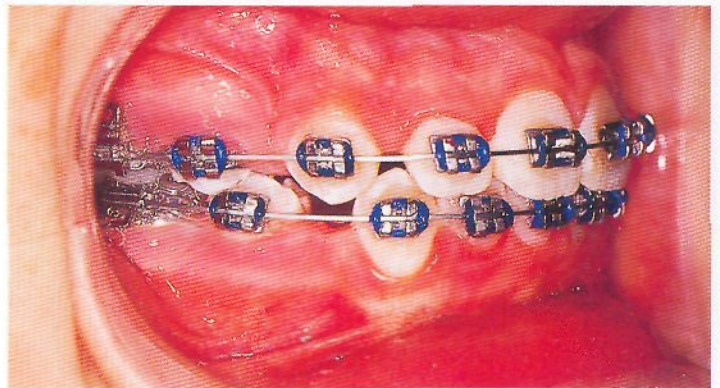


Fig. 9.97

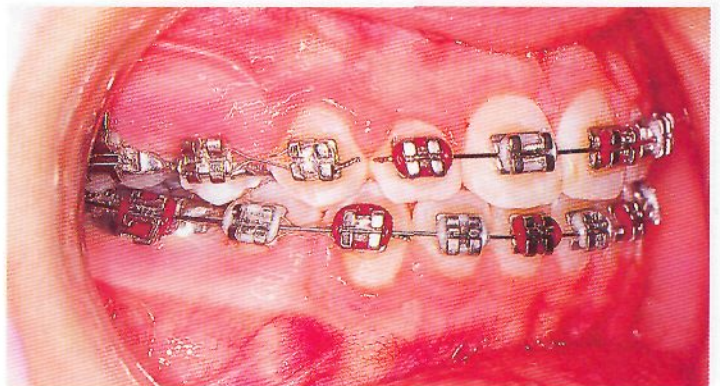


Fig. 9.100

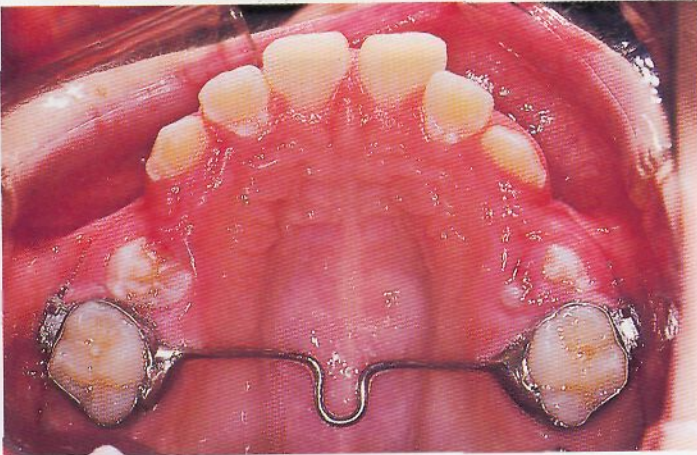


Fig. 9.93

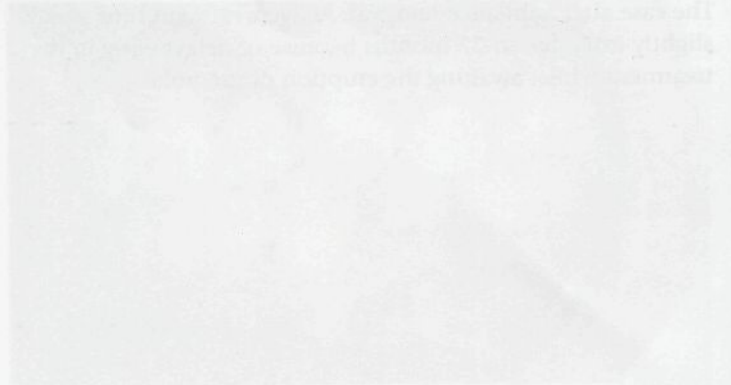


Fig. 9.94

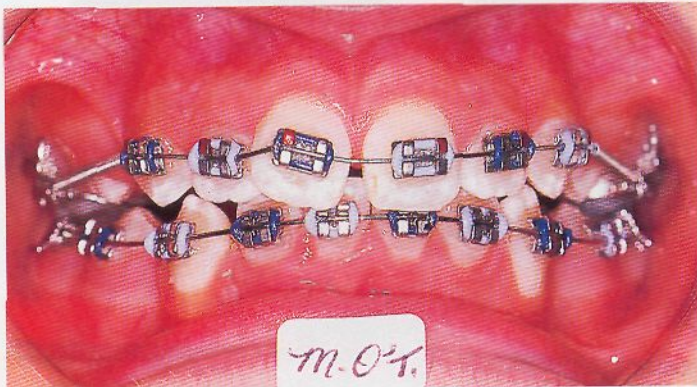


Fig. 9.95

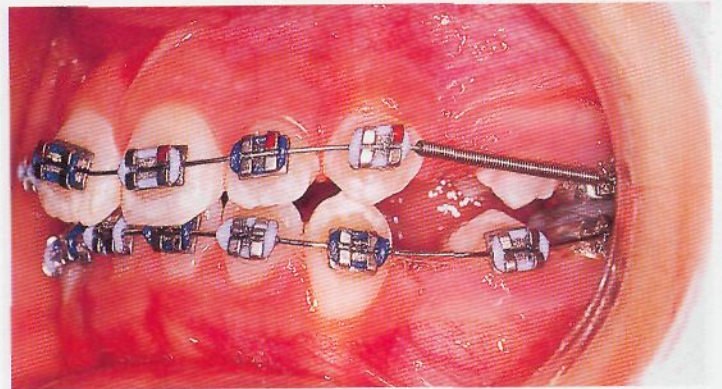


Fig. 9.96

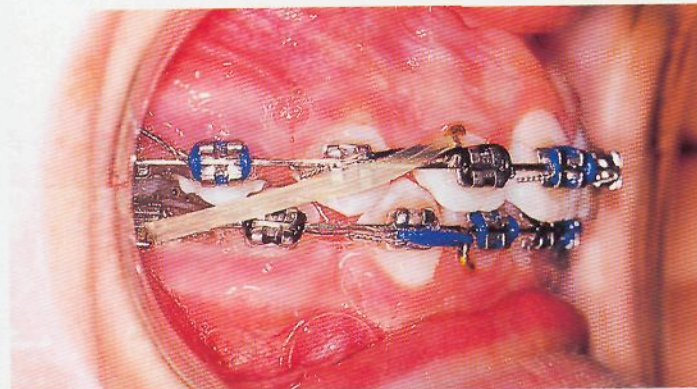


Fig. 9.98

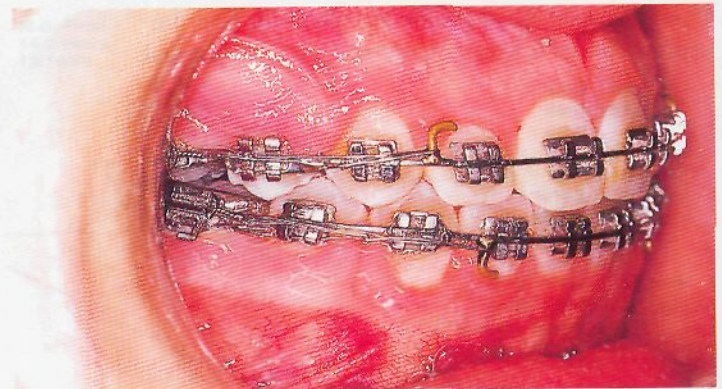


Fig. 9.99

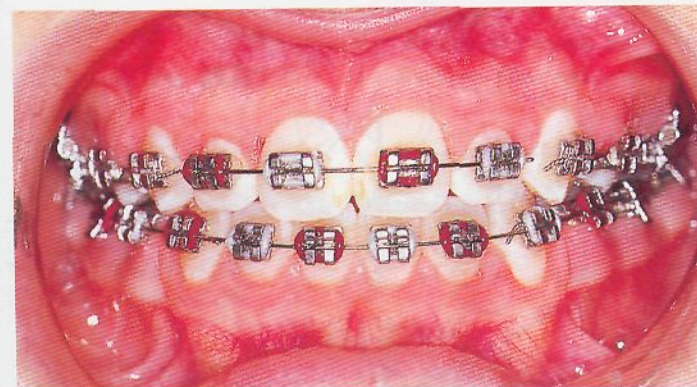


Fig. 9.101

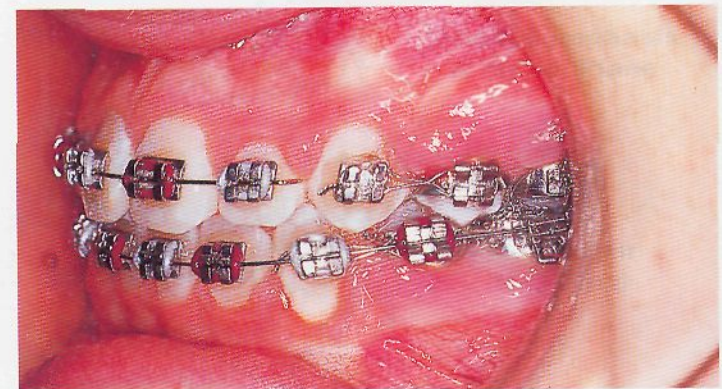


Fig. 9.102

The case after appliance removal. Active treatment time was slightly extended to 27 months because of delays early in the treatment whilst awaiting the eruption of premolars.

Normal retention, with lower retainers extended onto the lower second premolars. The post-treatment radiographs suggest there is adequate space for eruption of the third molars, and confirm a good relationship between the upper canine roots and upper second premolar roots.

Post-treatment facial profile was pleasing, and the cephalometric measurements were close to normal.



Fig. 9.103



Fig. 9.106



Fig. 9.109

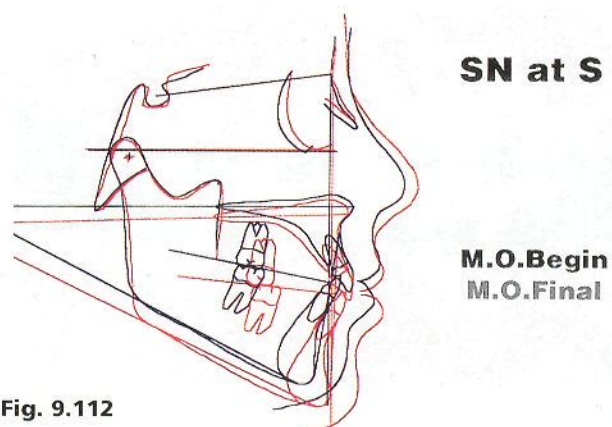


Fig. 9.112



Fig. 9.104



Fig. 9.105

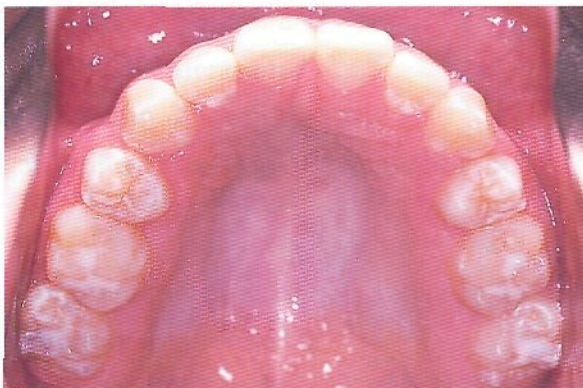


Fig. 9.107

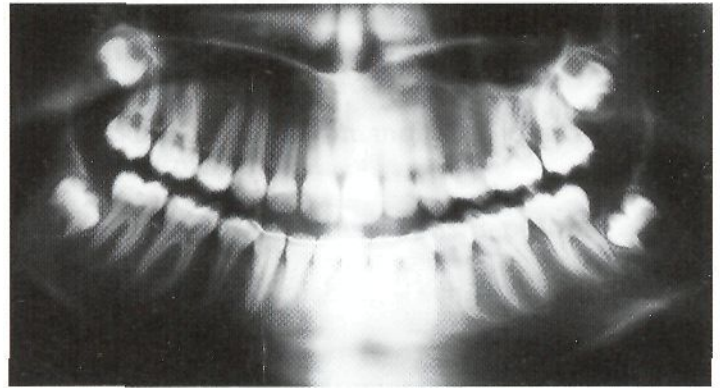


Fig. 9.108



Fig. 9.110

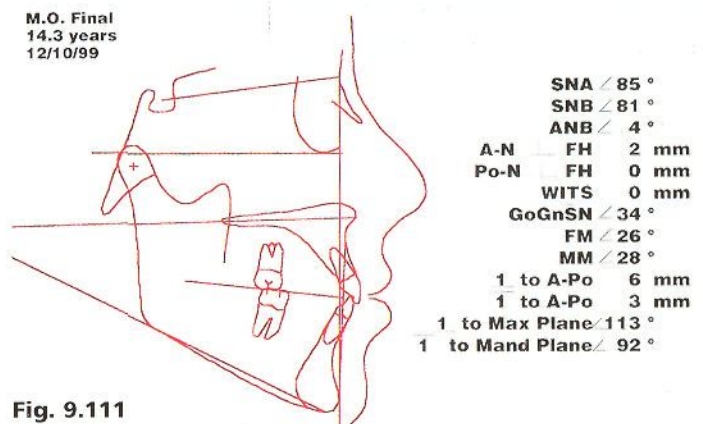


Fig. 9.111

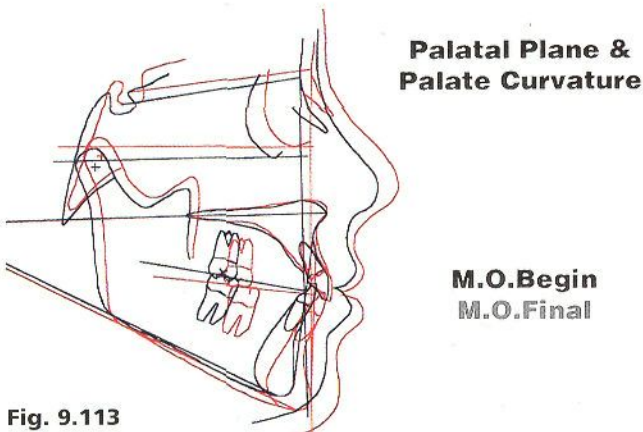


Fig. 9.113

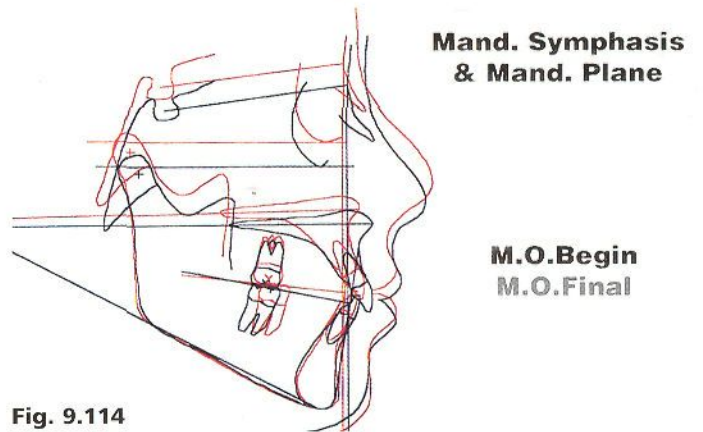


Fig. 9.114

Finishing the case

Introduction 280

Horizontal considerations 282

- Coordination of tooth fit 282
- Establishing correct tip of the anterior and posterior teeth 283
- Providing adequate incisor torque 284
- Management of tooth size discrepancies 285
- Controlling rotations 285
- Maintaining the closure of all spaces 286
- Horizontal overcorrection 286

Vertical considerations 288

- Correct crown lengths, marginal ridge relationships, and contact points 288
- Final management of the curve of Spee 288
- Vertical overcorrection – deep-bite and open-bite cases 289

Transverse considerations 289

- Arch form 289
- Archwire coordination 289
- Establishing posterior torque 290
- Transverse overcorrection 291

Dynamic considerations 291

- Establishing centric relation and checking functional movements 291
- Checking for temporomandibular joint dysfunction 292

Cephalometric and esthetic considerations 293

The final stage of finishing – settling the case 294

Finishing to ABO requirements 296

Case MB A high angle non-extraction case which required upper incisor torque and lower incisor enamel reduction 298

INTRODUCTION

During this last stage of treatment, finishing and detailing, it is important to continue to focus on treatment goals. As stated at the outset, in the preface, these are as follows:

- Condyles in a seated position – in centric relation
- Relaxed healthy musculature
- A 'six keys' Class I occlusion
- Ideal functional movements – a mutually protected occlusion
- Periodontal health
- Best possible esthetics.

Patients treated with the standard edgewise appliance required a significant amount of wire bending during the finishing stage of treatment (Fig. 10.1). In the earlier stages of treatment, the teeth were moved into a reasonable position

within each arch and the arches were brought into close proximity to one another. Then the tedious work of detailing began, and the best wire benders achieved the best results. Therefore, discussing finishing as an independent stage was appropriate, because it was a lengthy and challenging stage.

Because of the built-in features of the preadjusted appliance (Fig. 10.2), and the major emphasis on bracket placement, moving teeth to their finished positions begins as soon as the brackets have been placed and the first archwires tied in. There is a gradual flow toward the finishing stage, with less work required at the end. Finishing and detailing, as described in the authors' first book, is therefore no longer a separate and lengthy stage of mechanics, but more a rewarding outcome for good management of the case, earlier in the treatment.

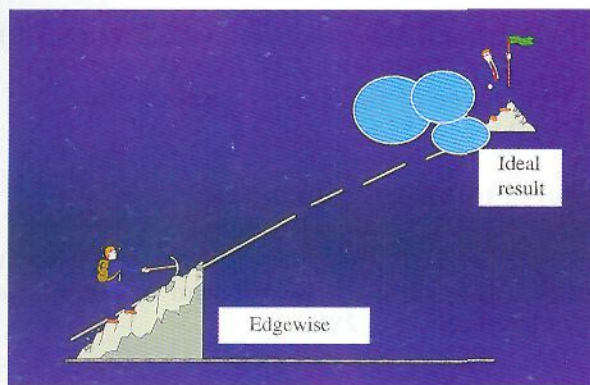


Fig. 10.1 It was difficult to achieve ideal results using the standard edgewise treatment system because of the large amount of tedious detailing which was required.

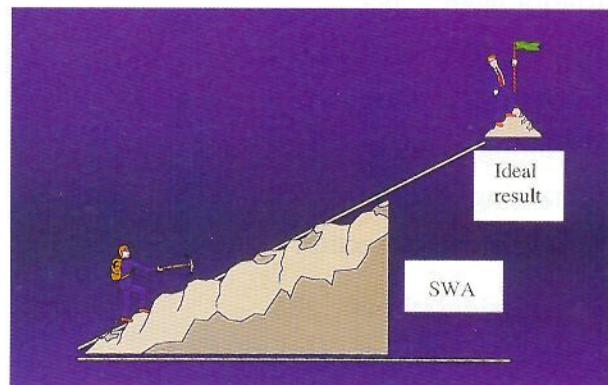


Fig. 10.2 The introduction of the preadjusted bracket system in the 1970s made achievement of ideal results easier.

For example, the more closely the appliance matches the mechanics of the orthodontist, the less work is required in finishing. The better the brackets are placed and repositioned as needed, the less work is required in finishing. The greater the attention paid to accurate arch form and archwire coordination, the less work is required in finishing. The less that force levels overpower the appliance system, moving teeth to inappropriate positions, the less work is required during finishing. And the list goes on! In other words, there is a gradual and progressive movement toward finishing, rather than an abrupt, clearly defined treatment stage (Fig. 10.3). Therefore, probably the greatest advantage of the preadjusted appliance is that it lets us redefine finishing and detailing as:

The correction of errors made prior to finishing and detailing, over-correction as needed, and settling of the case.

This chapter will review and summarize the horizontal, vertical, and transverse factors that allow the orthodontist to arrive at a well-finished case. The tooth movements during finishing and detailing are minor, and are difficult to record with photographs. Therefore, the chapter relies on text, rather than illustrations, to explain the necessary procedures.

During the closing stages of treatment attention needs to be given to the following considerations:

- Horizontal
- Vertical
- Transverse
- Dynamic
- Cephalometric and esthetic.

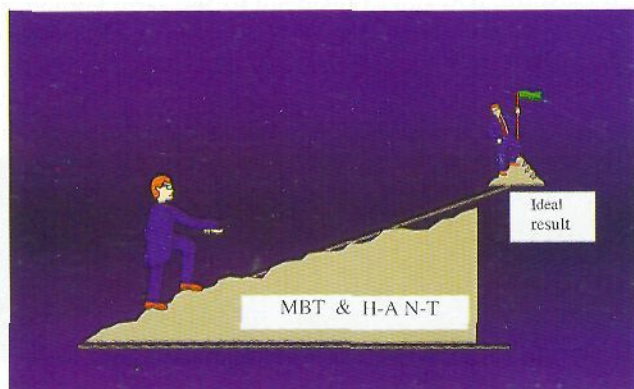


Fig. 10.3 Further improvements in technique have become possible using the MBT™ bracket system and HANT wires. Finishing and detailing are no longer a separate and lengthy stage of mechanics, providing the case has been well managed earlier in the treatment.

HORIZONTAL CONSIDERATIONS

Coordination of tooth fit

A major finishing consideration in the horizontal plane is the coordination of tooth fit in the anterior and posterior areas. The authors find that the anterior and posterior teeth fit well, with little or no adjustment, in approximately 20% of cases (Fig. 10.4). However, in approximately 60% of cases (Fig. 10.4), as the finishing stage approaches, it becomes clear that the crowns of the upper anterior teeth do not occupy enough space, relative to the crowns of the lower anterior teeth. The evidence may be seen in the following situations:

- Cases where posterior space closure is difficult in the upper arch while maintaining the correct amount of overjet (3–4 mm).
- Cases where the overjet is correct, but the buccal segments remain in a slight to moderate Class II position.
- Cases where complete space closure in the upper anterior segment is difficult while attempting to maintain the correct amount of overjet.

In approximately 20% of cases (Fig. 10.4), the authors find an excess of upper anterior tooth substance, relative to the lower. In these cases, the crowns of the teeth in the upper anterior segment are disproportionally larger than the crowns of the teeth in the lower anterior segment, and the patient shows some excessive overjet when the posterior segments are in a Class I relationship. This is seen in the following situations:

- In patients with large upper incisors
- In some Class III cases where upper incisors are proclined forward and lower incisors are retroclined.

These patients can be easily managed during finishing by carrying out some enamel reduction in the upper anterior segment and then closing the residual space.

The challenge, then, is dealing with the 60% of cases that show a relative shortage of tooth mass in the upper anterior segment. In the horizontal plane, this difficulty relates primarily to the factors of tip in the anterior teeth, incisor torque, and tooth size (Fig. 10.5). Each of these will be discussed below.

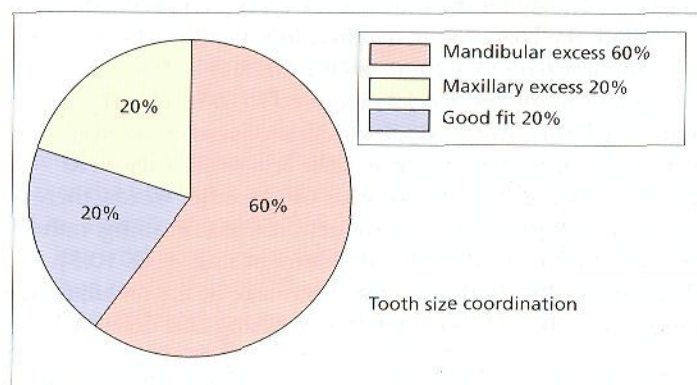


Fig. 10.4 Tooth size coordination.

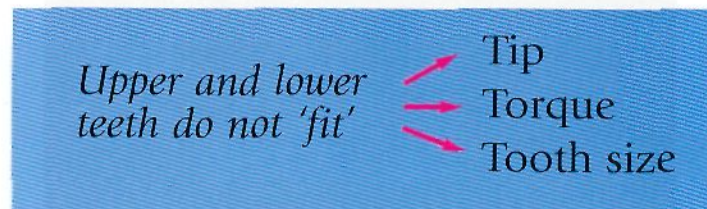


Fig. 10.5

Establishing correct tip of the anterior and posterior teeth

Tip is one of the strengths of the preadjusted appliance, especially when twin brackets with adequate width are used. Nearly full expression of the bracket tip is expressed with relatively little effort, and tip bends are normally not needed.

With the standard edgewise appliance, however, second order (tip) bends were placed in the archwires for two reasons. First, to properly move teeth relative to the 0° of tip in the bracket and, second, to compensate for the heavy forces used to move teeth. Therefore, unless overpowering forces are used during treatment with the preadjusted appliance, there should be little need to modify the tip measurements obtained by Andrews in his study of the non-orthodontic normal models. This has been the choice of the authors, and only minor tip modifications were made when developing the MBT™ appliance system, relative to the research figures.

Bracket tip is one of the main factors that influence the amount of space occupied by each tooth. This in turn influences the way the upper teeth fit with the lower teeth. When using anterior brackets with precisely Andrews' original tip measurements, a total of 40° of tip is placed in the upper anterior segment, and only a total of 6° in the lower anterior segment (Fig. 10.6). The resulting 34° of 'tip differential' helps to increase the size of the upper anterior segment and decrease the size of the lower anterior segment. This helps to achieve improved tooth fit within the 60% group described above.

The shape of incisor crowns needs to be assessed during finishing. Tipping incisor crowns, which are barrel or triangular shaped, will have little effect on the arch length occupied (Fig. 10.7). However, barrel-shaped crowns are fortunately rare. Triangular-shaped crowns will normally be reshaped to a more rectangular form, by the orthodontist, for esthetic reasons. So crown shape is seldom an issue, except at the treatment planning stage.

When designing the MBT™ upper premolar brackets, the tip was slightly modified, relative to the research figures. The change was from 2° to 0° of tip. This was to help tooth fit, and to position the upper premolar crowns in a slightly more upright position, which is more toward a Class I position from a starting Class II malocclusion. The MBT™ lower bicuspid brackets have 2° of tip, which is the research figure, and this inclines them toward a Class I position from a starting Class II relationship.

Molar tip of 5° in the upper and 2° in the lower is required. These tip values position the molar cusps parallel to the occlusal plane, which is correct. This tip is achieved by using MBT™ 0° brackets on all molars, and placing the bands parallel to the cusp tips (pp 66 & 67). This positioning allows the molars to settle into an ideal Class I relationship.

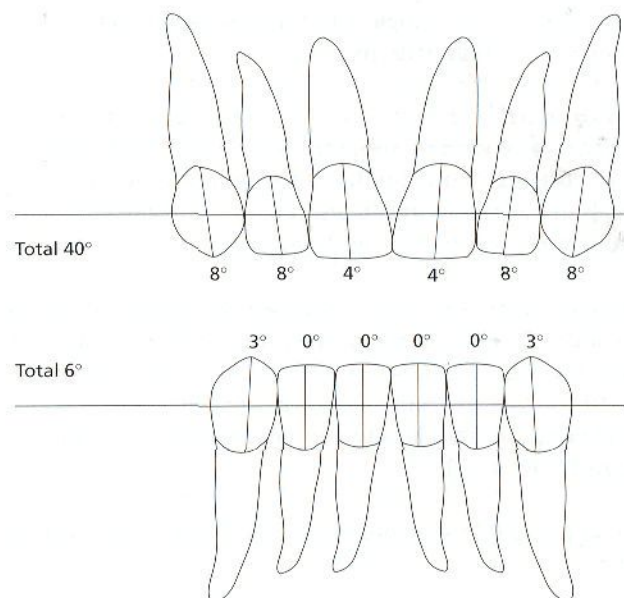


Fig. 10.6 The tip differential between upper and lower anterior segments helps to achieve improved tooth fit within the 60% group of patients where the crowns of the upper anterior teeth do not occupy enough space, relative to the crowns of the lower anterior teeth.

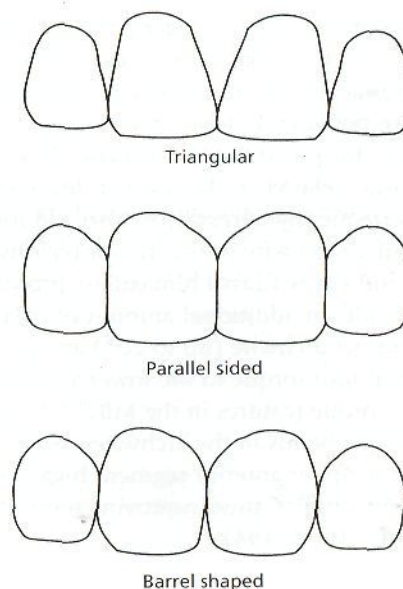


Fig. 10.7 The shape of incisor crowns needs to be assessed during finishing and settling.

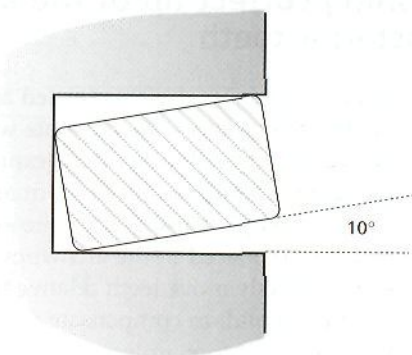
Providing adequate incisor torque

Torque control is the weakness of the preadjusted appliance system, and any system which is based on the edgewise bracket. There are three factors, and because of these, there does not seem to be a single set of torque values that will solve the needs of all patients:

1. Approximately a 1-mm segment of rectangular steel wire is placed in a bracket of about the same dimension. This is required to carry out a rather difficult tooth movement, which involves moving an entire portion of the root through alveolar bone (Fig. 10.8).
2. A full-size wire is normally not used because such wires do not slide efficiently through the posterior bracket slots. In order for sliding mechanics to be effective, the authors use a .019 × .025 wire in the .022 slot. This reduces the effectiveness of the rectangular wire, relative to torque control (Fig. 10.8).
3. The upper and lower anterior torque needs of patients vary greatly.

With most Class I and Class II patients, there is a tendency for upper incisors to be retroclined and lower incisors to be proclined. In Class III cases, the opposite tendency occurs. Because the majority of patients are either Class I or Class II in many practices, the general tendency in orthodontic appliances is to place additional palatal root torque in the upper incisor brackets and additional labial root torque in the lower incisor brackets.

When designing the MBT™ system, the authors chose to add an additional 10° of palatal root torque to the upper central incisor brackets, an additional 7° of palatal root torque to the upper lateral incisor brackets, and an additional 5° of labial root torque to the lower incisor brackets. This additional torque, relative to the research findings, is helpful. However, it is frequently necessary to also add torque bends to the rectangular steel wire in the incisor regions. In most Class II cases and many Class I bimaxillary protrusive cases, it is beneficial to add an additional amount of palatal root torque to the upper archwire (up to 20°) and an additional 10–15° of labial root torque to the lower archwire (Fig. 10.9). In general, the torque features in the MBT™ brackets, and appropriate torque bends in the archwires, where necessary, help to make the upper anterior segment bigger and the lower anterior segment smaller, thus improving tooth fit within the 60% group (Case TC, p. 194).



A .019/.025 rectangular wire with 2 mil radii will have 10° of slot play in the .022 slot

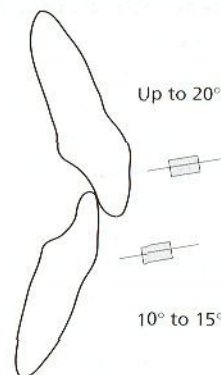
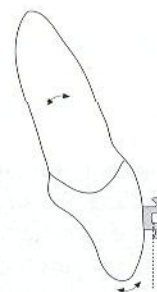


Fig. 10.8 The preadjusted appliance is not efficient at controlling torque owing to the small segment of rectangular steel wire and also owing to bracket 'slop'. It is frequently necessary to add torque bends to the rectangular steel wires in the incisor regions.

Management of tooth size discrepancies

Tooth size is actually the 'seventh key' to normal occlusion. It is clear that the Andrews' non-orthodontic normal models had balanced tooth size. If not, there would have been either spacing in one arch or crowding in the opposing arch.

As stated above, it is common to see a lack of tooth mass in the upper anterior segment relative to the lower anterior segment. Tooth size discrepancy frequently contributes to the situation. The most common anterior tooth size discrepancy consists of small lateral incisors in the upper arch and/or large lateral incisors in the lower arch. In the buccal segments, small upper second premolars frequently contribute to the tooth size discrepancy.

Evaluation of tooth size discrepancy can be carried out by using the Bolton analysis.¹ Tooth size discrepancy may be corrected either by reducing tooth mass in one arch with inter-proximal enamel reduction (usually the lower incisors) and/or by addition of tooth mass with restorative materials in the opposing arch (usually the upper lateral incisors).

It is more common to find an excess of tooth substance in the lower arch. If the Bolton analysis confirms this, it is often advisable to carry out inter-proximal enamel reduction in the lower anterior region in the initial stages of treatment (Case MS, p. 236). Only minimal amounts of tooth mass should be removed from the upper anterior segment, early in treatment. As the finishing stage of treatment is approached, the relative tooth mass in the upper anterior segment can be evaluated. If there is an excess of upper anterior tooth mass as a result of lower tooth mass reduction, then stripping procedures can be carried out in the upper anterior segment. If enamel reduction is done in the upper arch too early in treatment, spacing may result, which can only be corrected by the addition of bonding material.

Controlling rotations

Rotation control is an important aspect of finishing and detailing. Fortunately, the in-out compensation built into the preadjusted appliance, combined with correct bracket positioning, is most effective in controlling rotations. The most obvious example of this is the 10° of rotation that is introduced into the brackets of the upper molars, and the 0° of rotation placed in the lower molars. This combination is most beneficial in allowing the upper molars to occlude properly in a Class I position with the lower molars.

It can be beneficial in Class I and Class II cases to place upper premolar brackets approximately 0.5 mm to the mesial. This allows the buccal cusps of the upper premolars to rotate distally toward a Class I position, and the palatal cusps of these teeth to rotate mesially so that they occlude more accurately into the fossae of the lower arch. If anterior teeth show rotation at the beginning of treatment (Fig. 10.9), it is beneficial to place the bracket slightly in the direction of the rotation to aid in their correction (p. 61). Also, it is beneficial to place lower canine brackets slightly to the mesial. This rotates the mesial aspect labially and provides better contact with the distal aspect of the lower lateral incisors.

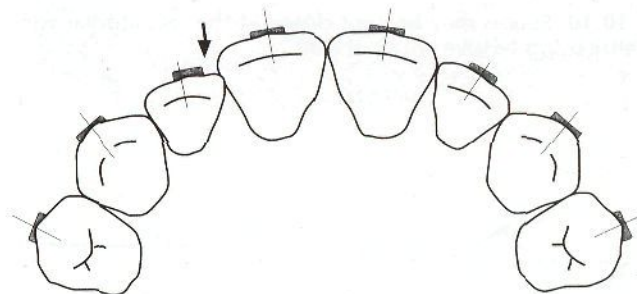


Fig. 10.9 Accurate bracket positioning at the start of treatment can assist in rotation control during the finishing stages.

Maintaining the closure of all spaces

It is important to keep spaces closed during the finishing stage of treatment, particularly in extraction cases. This can be accomplished with passive wire tiebacks (Fig. 10.10) when rectangular wires are in place, and with lacebacks from molars to cuspids when light wires are in use. In extraction cases, during the settling stage, figure-8 ligature wires (Fig. 10.11) should be placed across the extraction site to keep them closed. Also, in any other areas where space closure was somewhat difficult, figure-8 ligature wires or light elastic thread should be used to maintain space closure during settling. Carrying out these simple procedures eliminates the troublesome problem of spaces opening in the finishing stages of treatment.

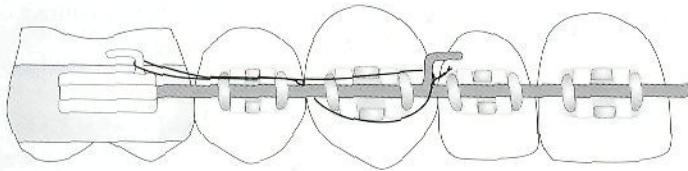


Fig. 10.10 Spaces may be kept closed at the rectangular wire stage by using passive wire tiebacks.

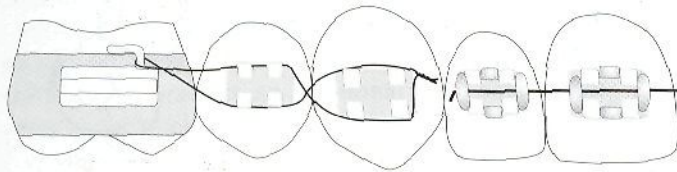


Fig. 10.11 When treating premolar extraction cases, figure-8 ligature wires should be placed across the extraction site during the settling stage to prevent spaces from opening.

Horizontal overcorrection

It is often necessary to consider horizontal overcorrection of Class II and Class III cases. During the finishing stages of treatment, it is important to fully correct the A/P position of the dentition using methods such as Class II or Class III elastics, or headgear, for example. After correction has been completed, then these methods of tooth movement can be discontinued or worn on a part-time basis. The patient may then be observed for a period of 6 to 8 weeks. If the case appears to be stable, the appliances can be removed. If not, these cases can be horizontally overcorrected.

In Class II cases, the anterior teeth can be brought to an edge-to-edge position and held for approximately 6 to 8 weeks (Fig. 10.12). After this, elastics can be discontinued or worn at night only, to see how the case is settling.

A Class III case can be horizontally overcorrected by producing 2–3 mm of additional overjet, and this may then be held or observed in a similar manner to Class II cases.

Even if these overcorrection techniques are carefully followed, problems can occur during retention. These can be due to late aberrant growth, or to re-established tongue or finger habits, for example. These concerns need to be explained to patients, and observation at regular intervals during retention is in their best interest.

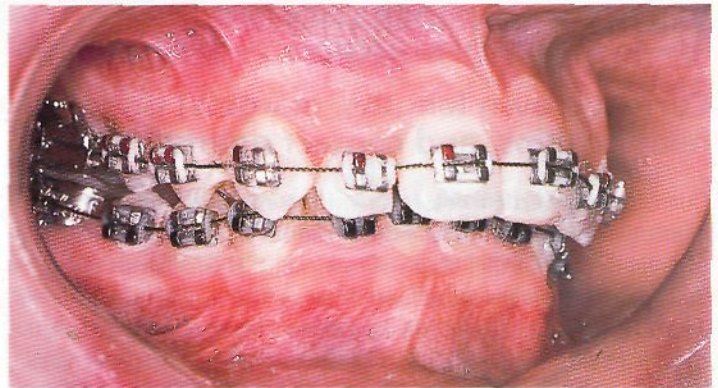
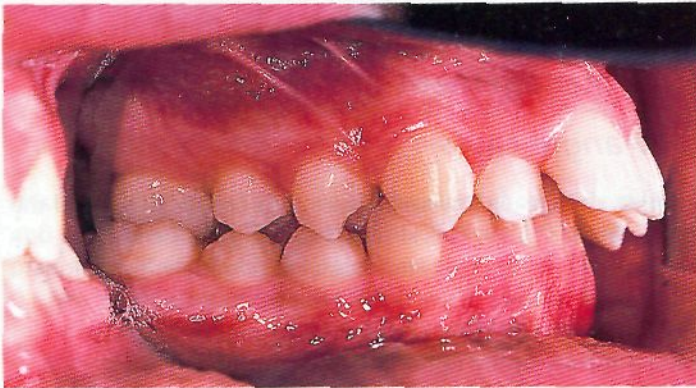


Fig. 10.12A and B This low-angle Class II/1 malocclusion was managed without headgear, but included the extraction of upper second permanent molars. Standard metal brackets were used. The case is seen here before treatment, and after placement of initial .015 multistrand upper and lower aligning wires.

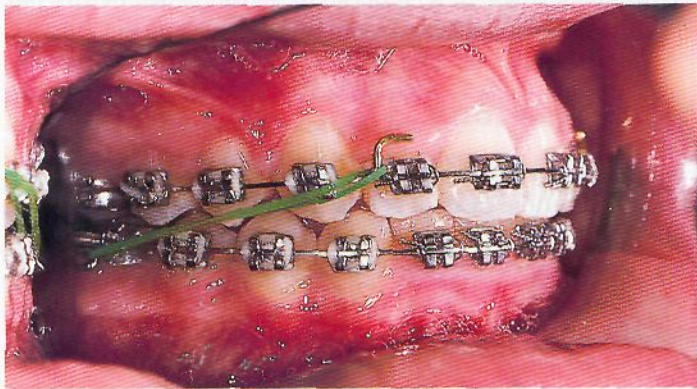


Fig. 10.12C and D Upper and lower rectangular steel wires and Class II elastics were used for overjet correction. When finishing the case, a .014 round wire was used in the upper arch, with light Class II mechanics to ensure over correction of the overjet and overbite.

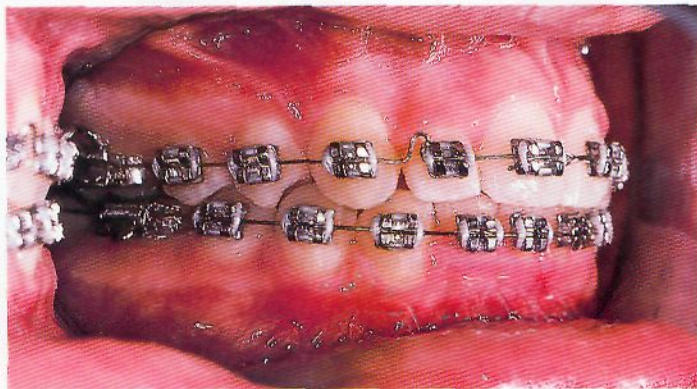


Fig. 10.12E and F Here the case is seen prior to band removal, after a small amount of settling has occurred with the appliances in place. Finally, the case is seen 18 months after band removal, with good settling and improved oral hygiene.

VERTICAL CONSIDERATIONS

Correct crown lengths, marginal ridge relationships, and contact points

Correction of vertical crown positions, marginal ridge relationships, and contact points should be completed during the rectangular HANT stage of treatment. If this is not done, these corrections must be made during the finishing and detailing stage of treatment, shortly before bracket removal. This does not ensure stability of vertical tooth positions. It is much better for stability to allow these relationships to be correct for 1 to 2 years before bracket removal. Correct bracket placement at an early stage is critical for stability.

The chapter on bracket placement (p. 62) discusses in detail the technique used by the authors for proper vertical bracket placement. The charts have been used for 6 years and have proven to be most effective. They have reduced the need for bracket repositioning by approximately 50%, and have enhanced the efficiency of treatment and the stability of results.

As discussed earlier, upper canines and lower first premolars frequently have long and pointed cusps, and for such teeth the bracket positioning should be approximately 0.5 mm more gingival. This will minimize the need of settling or detailing bends at the end of treatment (Fig. 10.13).

The posterior figures on the bracket-positioning charts (p. 63) are based on averages, for teeth with normal marginal ridges, in correct position. However, for posterior teeth with cusp heights which vary from the norm, or with abnormal marginal ridges, bracket positions may need to be slightly modified to accommodate these differences. The need for this can easily be observed at the rectangular HANT stage of treatment. Brackets can then be repositioned to correct the marginal ridges at that time.

It is sometimes necessary to make minor archwire bends in the finishing stages of treatment, to correct improper vertical bracket position, but these procedures are somewhat unstable near the end of treatment. It is far better to correct vertical bracket positions much earlier in treatment.

Final management of the curve of Spee

Low-angle cases

In most average- to low-angle cases, it is beneficial to level the entire curve of Spee. This should include placement of brackets or bands on second molars to complete the process. If the curve of Spee is not fully corrected in these cases, the lower incisors will be positioned more gingivally on the palatal surface of the upper incisors. This may make it difficult or impossible to complete final space closure in the upper arch and to keep these spaces closed. If the bite is opened properly and the curve of Spee is level, it is then possible to complete space closure in the upper arch with stability. Upper bite-plate retainers should be considered in cases that show a tendency for bite deepening during retention. This type of relapse can be accompanied by spacing in the upper arch and/or crowding in the lower arch.

High-angle cases

High-angle cases with open-bite tendencies must be handled carefully. In these cases, it is important to leave some curve of Spee in the back of the arch, particularly in the second molar area. This allows the bite to remain closed anteriorly. If the back of the curve of Spee is leveled in such cases, there is a great risk of anterior open bite. For patients near the end of the growth period, it may be difficult or impossible to close this anterior open bite.

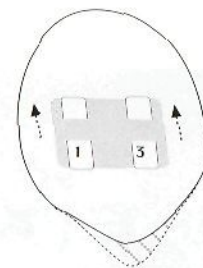


Fig. 10.13 Correct vertical bracket positioning will minimize the need for detailing bends at the end of treatment.

Vertical overcorrection – deep-bite and open-bite cases

It is beneficial to introduce some overcorrection in deep-bite and open-bite cases. This process begins with initial bracket placement. Brackets on the anterior teeth can be placed 0.5 mm more gingival in open-bite cases and 0.5 mm more incisal in deep-bite cases (p. 65). This greatly assists in the overcorrection process.

In deep-bite cases, leveling of the curve of Spee with flat steel rectangular archwires normally results in effective bite opening, provided the second molars are included. If bite opening is not achieved using flat rectangular steel wires, then bite-opening curves can be placed. This can be done as late as the finishing stage of treatment, but it is normally completed earlier. Toward the end of treatment in deep-bite cases, patients may have only 1–2 mm of overbite. However, they will generally settle into a position with approximately 3–4 mm of overbite. Bite-plate retainers are most beneficial in these cases to prevent subsequent overclosure of the bite.

Open-bite cases present a great challenge to the orthodontist. It is important to evaluate tongue position and tongue habits in the finishing stages of treatment. Hopefully, this problem was observed prior to this stage, and myofunctional therapy initiated if the habit was not corrected. These cases will often benefit from the use of positioners to help bite closure. If a conventional upper retainer is to be used, a small hole can be placed in the palatal surface of the acrylic, for tongue positioning. In this way, some patients learn to modify their tongue position or activity, by holding the tip of the tongue in the roof of the palate during swallowing and other activities. However, in some cases, a tongue will reassert itself, despite the best efforts of the patient and the orthodontist. The patient should be informed of this possibility before treatment.

TRANSVERSE CONSIDERATIONS

Arch form

If a single arch form is used for every patient, it will give efficiency in arch form management. However, accuracy and stability cannot be achieved in this manner. The key to good arch form management is to have a balance between efficiency and accuracy. The arch form system described in Chapter 4 consists of the following elements:

- Three standard templates (square, tapered and ovoid) to establish arch form throughout the round wire stage and rectangular heat-activated stage. This is an efficient way of managing the early stages of treatment.
- Use of a wax template compressed over the brackets in the lower arch, before placement of the steel rectangular wire. The shape of the rectangular steel wire is then based on the wax template. It is evaluated and adjusted after reference to the patient's lower study model. This becomes the patient's individual arch form (IAF). This simple technique provides accuracy in the arch form system.
- Allowing the case to settle with a light wire (as opposed to the rectangular stainless steel wire) as the last treatment procedure. This technique will be described at the end of the chapter.

Archwire coordination

In all wire sizes, once the lower arch form has been established, the upper archwire needs to be coordinated to the lower archwire. In general, this is achieved by adjusting the upper archwire so that it is 3 mm wider anteriorly and posteriorly than the lower archwire. This helps to establish the correct 3 mm of overjet both anteriorly and posteriorly. Because of posterior torque considerations (see below), it may be beneficial in many cases to widen the upper arch in the posterior segments to approximately 5 mm. If these procedures are followed during treatment, there is normally little need to adjust archwire coordination during the finishing stages of treatment.

Some cases may show slight narrowing in the posterior segments near the end of treatment, and a .045 archwire can be coordinated with the upper arch form and widened approximately 6 mm per side. It can then be secured to the upper arch in the headgear tubes (p. 82). This supplemental or 'jockey wire' is beneficial in taking care of minor maxillary narrowing in the finishing stages of treatment.

Establishing posterior torque

Progressive buccal crown torque has been designed into the appliance system in the lower posterior segments, as described in Chapter 2 (p. 33), and this has been a significant improvement. When the rectangular stainless steel wire is placed in the brackets, the lower posterior segments move to an upright position, providing a relatively flat curve of Wilson (Fig. 10.14). This does have a slight widening tendency in the lower arch. However, if arch form is maintained relative to the basal bone of the mandible, this effect is minimal.

Typically, the lower posterior roots move lingually, away from the cortical plate, rather than the crowns moving buccally.

The upper cuspid and bicuspid brackets have -7° of buccal root torque, and this positions them ideally relative to the lower arch. Upper molars have been provided with additional buccal root torque, relative to the research findings, which helps to place them into the proper position. However, there are many cases where additional buccal root torque needs to be added to the posterior segments of the upper archwire.

Due to the anatomy of the upper molar roots, it is important to have adequate width in the maxillary bone, so that the buccal roots are not compressed against the cortical plate (Fig. 10.15). If this occurs, it may be impossible to establish correct buccal root torque in the upper posterior segments.

Finally, the placement of the upper .045 'jockey wire' in the headgear tube (p. 82) is beneficial in many cases. Following the widening effect of this wire, it can be removed, and additional buccal root torque can be placed in the rectangular stainless steel wire. This allows the posterior teeth to move into their proper positions. Then, in the final stage of settling of teeth at the end of finishing, the upper posterior segments normally settle properly with the lower posterior segments.

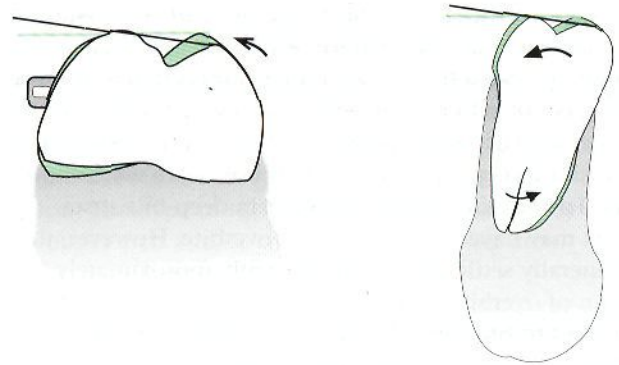


Fig. 10.14 During correction of torque, lower posterior roots move lingually away from the cortical plate, and the crowns move slightly buccally, if arch form is maintained relative to the basal bone of the mandible.

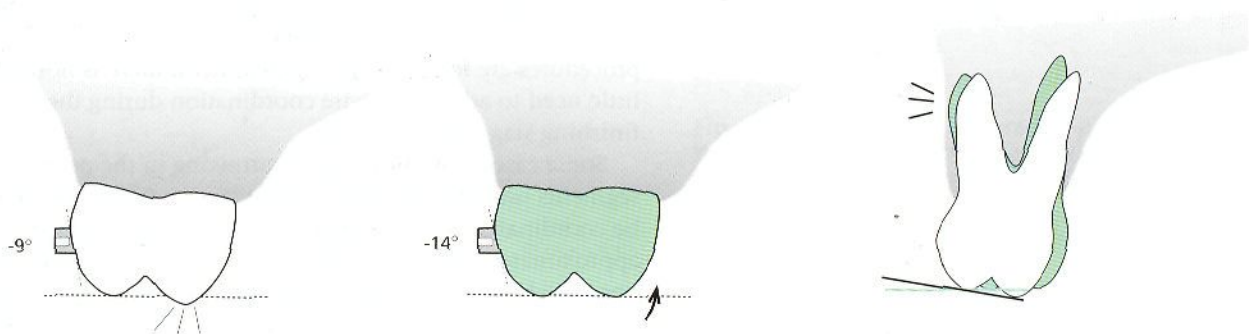


Fig. 10.15 It is important to have adequate maxillary bone for correct buccal root torque in the upper molar regions.

Transverse overcorrection

Cases that show narrowing in the maxilla should be adequately overexpanded and held in the expanded position for an extended period of time. The maxilla can be expanded until the palatal cusps of the upper arch are in contact with the buccal cusps of the lower arch in the posterior segments (Fig. 10.16A). It is best to expand cases 1 or 2 years prior to full orthodontic treatment, and to maintain this expansion with a palatal bar. Then stability is normally assured.

If expansion is carried out at the beginning of orthodontic treatment, a palatal bar should be placed after the expansion procedures. This palatal bar can remain in position until the rectangular stainless steel wire has been placed. This wire provides adequate stiffness to maintain the expansion that has been achieved. Torque in the posterior brackets of the upper arch, as well as some additional buccal root torque in the archwire, is beneficial at this time, to allow the posterior segments to settle properly.

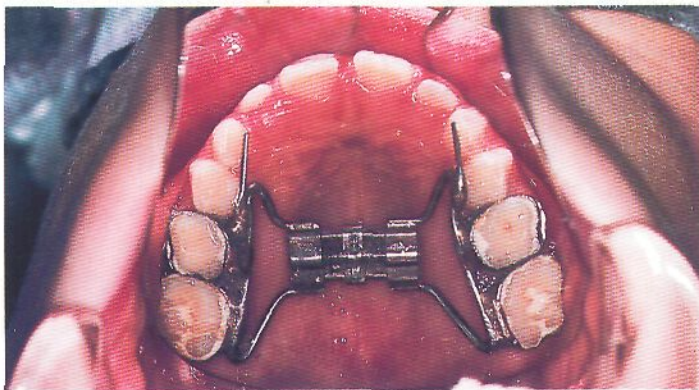


Fig. 10.16A Cases which show narrowing in the maxilla can be expanded using rapid palatal expansion in the mixed dentition. This expansion can be maintained with a palatal bar, and it assists in achieving adequate buccal root torque in the upper posterior segments.

DYNAMIC CONSIDERATIONS

Establishing centric relation and checking functional movements

It is important to evaluate orthodontic cases in centric relation at the beginning of treatment. If not, major diagnostic errors can be made. This position needs to be monitored throughout treatment and it is essential to re-evaluate mandibular position as the finishing stage of treatment commences (Fig. 10.16B). It may be that additional correction is needed, for example with inter-maxillary elastics, prior to finishing of the case. Patients with occlusion in a Class I position and with the condyles in centric relation, can then be checked for interference during protrusive and lateral excursions. During protrusive movement, it is important that the lower eight most anterior teeth make contact with the upper six most anterior teeth, with no posterior contact. During lateral excursions, the patient should experience cuspid rise with slight anterior contact and disclusion of the posterior teeth on both the working and the balancing sides.²



Fig. 10.16B Mounted models may be used to re-evaluate mandibular position and check functional movements as the finishing stage commences.

Checking for temporomandibular joint dysfunction

It is important to document any evidence of temporomandibular joint (TMJ) dysfunction prior to treatment, and inform the patient that the condition exists. Asymptomatic clicking is generally not treated prior to orthodontics, but monitored as treatment proceeds. If muscular imbalances and/or pain exist, and centric relation cannot be accurately recorded, then a phase of splint therapy and physical therapy is indicated prior to orthodontics. After the patient has been stabilized, orthodontic treatment can be commenced.

Patients should also be monitored during orthodontic treatment, in case TMJ symptoms develop. If these symptoms are managed when they first occur, prior to the formation of true internal derangement, then frequently normal TMJ function can be re-established without permanent damage. If symptoms do develop, it is first beneficial to eliminate the use of all forces, such as headgear and elastics, while resolving the TMJ problem. The patient is asked to remain on a soft diet, and use conservative measures to manage the symptoms.

If symptoms persist, then splint therapy and physical therapy can be initiated and orthodontic treatment delayed for a short period. Orthodontic treatment can then resume and proceed in a normal fashion with most patients. It is generally accepted that a seated and reasonably centered condyle position is the most beneficial position to establish during orthodontic treatment. Condyle position can be evaluated clinically with mandibular-positioning techniques, and radiographically with corrected tomography. While some

clinicians feel that such radiographs are important in all cases, the authors do not routinely take tomographs unless symptoms are detected.

In most cases, minor changes can be made during the finishing stage of treatment to allow for correction of condyle and mandibular positions. For example, if the patient shows an anterior skid with a corresponding anterior condyle position, it is beneficial to continue with headgear or Class II mechanics for an additional period of time to eliminate the anterior skid and allow the condyles to seat in the fossae (Fig. 10.17).

Conversely, if the patient shows a significantly posterior condylar position with no evidence of an anterior skid, it is beneficial to provide a slight amount of anterior skid so that the condyle can be in a more centered position. This may be achieved by ceasing Class II elastics or headgear, or by the use of Class III elastics, and is particularly important in cases that show a Class III growth tendency (Fig. 10.18).

Finally, if the condyles are in a seated and reasonably centered position, with the dentition in a settled Class I position, appliances can be removed. This should allow normal TMJ development and function after orthodontic treatment. Patients should be monitored during the retention phase of treatment to determine if TMJ symptoms occur. Orthodontists cannot predict the physical and emotional stress levels that will occur with their patients, but they can provide the most satisfactory structural environment to best withstand these stressful forces.

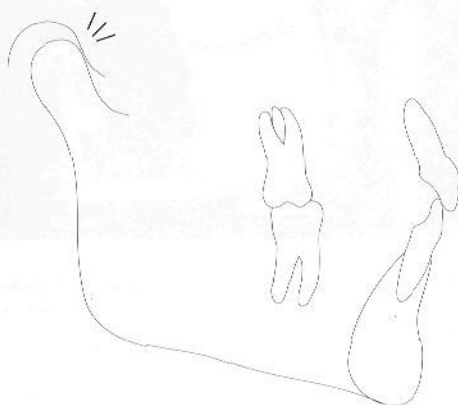


Fig. 10.17 If the patient shows an anterior skid, with a corresponding anterior condyle position, it is beneficial to continue with headgear or Class II mechanics to allow the condyles to seat in the fossae.

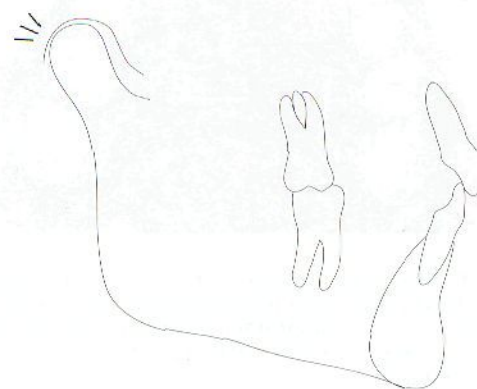


Fig. 10.18 If the patient shows a significantly posterior condylar position, further treatment should be provided, to achieve a more centered position.

CEPHALOMETRIC AND ESTHETIC CONSIDERATIONS

It is often helpful to take progress headfilms approximately halfway through orthodontic treatment to determine how the skeletal, dental, and soft tissue components are being managed. Progress headfilms allow for reassessment of anchorage factors and help revisions in treatment planning as treatment proceeds. For some patients, it is necessary to take a final cephalometric radiograph. These should be taken approximately 3 to 4 months before debanding, rather than after treatment. Taking headfilms after completion of treatment is useful from a learning standpoint for future cases, as well as to evaluate the success or failure of the treatment, but it provides no specific advantage for the patient. It is better to take the headfilm before the appliances are removed, so that tooth positions can be corrected if necessary, relative to PIP and other treatment goals for the case (p. 166).

The most important factors to be evaluated with these progress and final cephalometric radiographs involve the soft tissue profile, the antero-posterior position of the incisors, the torque of the incisors, the changes in the mandibular plane of the patient, the degree to which vertical development of the patient has occurred or been restricted, and the success in correcting the horizontal, skeletal, and dental components of the problem. Evaluation involves superimposition of progress and final radiographs with the initial cephalometric radiograph, to accurately determine the changes that occurred.

If treatment planning has been based on the Arnett³ analysis (p. 163), facial profile and the five dentoskeletal structures can be evaluated in the closing stages of treatment, before appliances are removed (Fig. 10.19). The Arnett dentoskeletal ideals are:

	female	male
• MxOP	95.6 ± 1.8	95.0 ± 1.4
• Mx1 to MxOP	56.8 ± 2.5	57.8 ± 3.0
• Md1 to MdOP	64.3 ± 3.2	64.0 ± 4.0
• overjet	3.2 ± 0.4	3.2 ± 0.6
• overbite	3.2 ± 0.7	3.2 ± 0.7

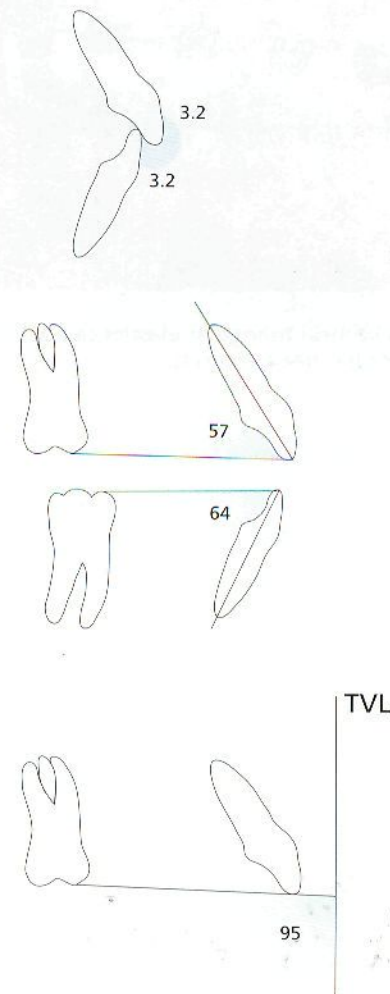
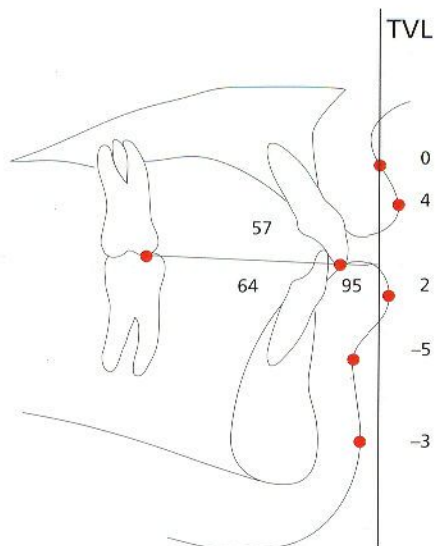


Fig. 10.19 During the final stages of treatment the Arnett analysis may be used to evaluate facial profile and dentoskeletal structures. The orthodontist can normally produce favorable change in incisor torque and overjet/overbite, if required, but may be less able to influence the position of the maxillary occlusal plane, relative to true vertical line (TVL).

THE FINAL STAGE OF FINISHING – SETTLING THE CASE

Rectangular stainless steel working wires are required for overbite control, A/P correction, and space closure, but they are somewhat restrictive for settling of the teeth in the closing stages of the treatment. Much lighter wires are therefore used. Typically, a .014 or .016 round HANT wire is used in the lower arch, coordinated to the IAF for the patient. In the upper arch, a .014 round sectional wire can be placed from lateral incisor to lateral incisor. These wires can be accompanied by the use of vertical triangular elastics where settling needs to occur. The better the bracket placement, the

less elastics need to be used in this way. It is beneficial to keep all bands and brackets on the teeth during settling, so that if unwanted changes occur, these can be corrected.

Managing the case in this manner allows teeth to individually settle into their final positions before appliance removal. Patients can be seen at approximately 2-week intervals during the settling phase. Elastics can be worn full time for the first 2 weeks, then at night for a period of 2 weeks, if settling is adequate. Debanding can then be scheduled.

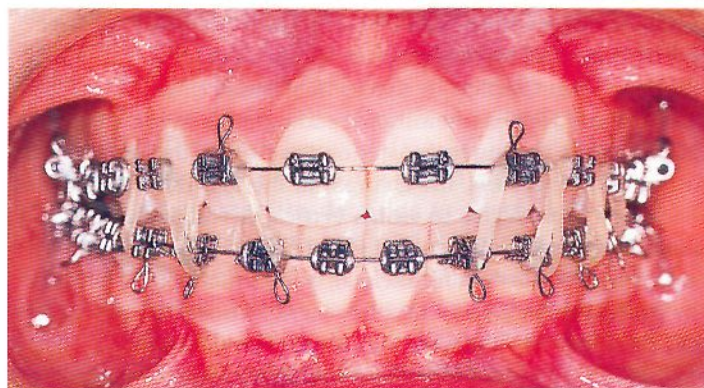
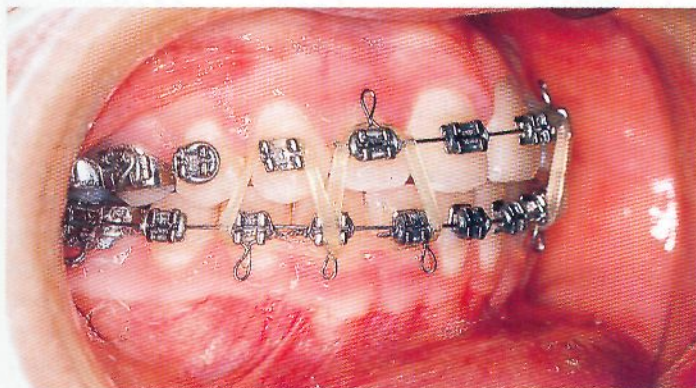


Fig. 10.20 Light vertical triangular elastics can be used where settling needs to occur. Fewer elastics of this type will be required if bracket placement has been accurate.

Some variations to this general settling technique are as follows:

- If cuspids were labially displaced in the upper arch, the sectional wire in the upper anterior segment can be extended to the cuspids to hold them in position.
- If diastemas were present in the upper and lower anterior segments, these areas should be tied together lightly with elastic thread or ligature wires (Fig. 10.21).
- If teeth have been extracted, figure-8 ligature wires should be placed across the extraction sites to hold them closed.
- If palatal expansion was carried out, a small removable palatal plate, with .018 wires extending inter-proximally in the gingival areas, can be used to maintain expansion during the settling phase (Fig. 10.22).
- When finishing moderate to severe Class II/1 malocclusions, it is not wise to use a small sectional wire for the upper anterior segment, because some return of the overjet can be expected. In this situation, a full upper .014 archwire can be used in settling (Case DO, p. 210) and this wire can be bent back behind the most distal molars. This controls the overjet, but inhibits settling of the posterior teeth somewhat. Archwire bends may therefore be placed where individual teeth need to settle.
- If it is intended that settling may take longer than approximately 6 weeks, it is beneficial to leave the lower rectangular steel wire in position during this extended settling phase. This will help to maintain lower arch form. An example of this might be a difficult posterior open bite that will require a more extended period of time for settling. When it is anticipated that only 4 to 6 weeks of treatment is remaining, a normal lower .014 steel or .016 heat-activated wire can be placed.

Occasionally, settling does not proceed as expected and it may be necessary to return to the rectangular stainless steel wires. On occasion, it may be necessary to reposition some brackets to allow the arches to re-level and settle properly. This, of course, should have been accomplished at an earlier stage of treatment, but occasionally it is necessary. Once the orthodontist is satisfied that teeth have settled into a satisfactory position, retainer impressions can be taken and the patient scheduled for debanding procedures.

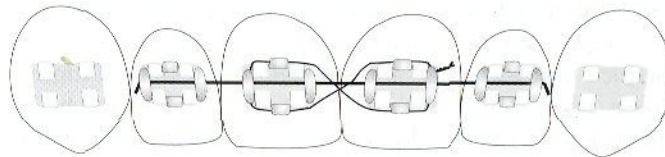


Fig. 10.21 During settling it is necessary to lightly tie incisors together if a diastema was present at the start of treatment.

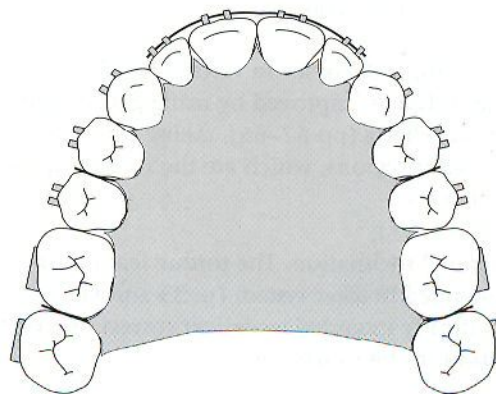


Fig. 10.22 A removable palatal plate can be used during settling to maintain upper arch expansion.

FINISHING TO ABO REQUIREMENTS

In July 2000, the American Board of Orthodontics (ABO) came out with revised requirements and a grading system for dental casts and panoramic radiographs.⁴ It is the authors' hope that this book will be helpful to readers wanting to reach ABO goals.

The ABO places emphasis on self assessment of seven features of dental casts. Interestingly, these seven criteria for cast evaluation quite closely match the finishing goals described in this chapter, and throughout the book. Progress models, taken in the finishing stages of treatment, and before appliance removal, should be checked for ABO requirements for any case which is intended for presentation. More specifically, these include:

- Tooth alignment. Almost 80% of malalignments were found to occur among lateral incisors and second molars. Care with bracket positioning (pp 61, 66, and 67) can help to eliminate such errors.
- Marginal ridges. Accuracy in vertical relationship of the marginal ridges is improved by using gauges and bracket positioning charts (pp 62–65), taking extra care in first and second molar regions, which are the most frequent problem areas.
- Buccolingual inclination. The torque features in the recommended bracket system (p. 33 and Fig. 4.40, p. 89) are specifically intended to deliver correct buccolingual inclination in the molar regions.

- Occlusal relationship. The A/P relationship of molars, premolars and canines is assessed using Angle's classification. Coordination of tip, torque, and tooth size (with correction where necessary) is required (p. 282), to achieve Class I occlusion, and this is a theme running throughout the book.
- Occlusal contacts. Good posterior occlusion can normally be achieved with the help of vertical elastics (p. 294). Additionally, well-constructed positioners can help to settle cases intended for ABO presentation. A common problem area was reported to be upper and lower second molars.⁴
- Overjet. Methods of overjet correction are reviewed in Chapters 7 and 8. Attention also needs to be given to tip, torque, and tooth size (p. 282).
- Interproximal contacts. Techniques for closing spaces (p. 254), and for keeping them closed during finishing (p. 286), have been described. Particular care is needed in adult extraction cases (p. 268).

Finally, concerning root angulation assessment using panoramic radiographs, it has been a consistent finding with the MBT™ system, that root angulations match the ABO requirements, especially concerning canine roots.

REFERENCES

- 1 Bennett J, McLaughlin R P 1997 Orthodontic management of the dentition with the preadjusted appliance. Isis Medical Media, Oxford (ISBN 1 899066 91 8) pp. 50–51. Republished in 2002 by Mosby, Edinburgh (ISBN 07234 32651)
- 2 Bennett J, McLaughlin R P 1997 Orthodontic management of the dentition with the preadjusted appliance. Isis Medical Media, Oxford (ISBN 1 899066 91 8) pp. 200–205. Republished in 2002 by Mosby, Edinburgh (ISBN 07234 32651)
- 3 Arnett G W, Jalic J S, Kim J et al 1999 Soft tissue cephalometric analysis: diagnosis and treatment planning of dentofacial deformity. American Journal of Orthodontics and Dentofacial Orthopedics 116:239–253
- 4 The American Board of Orthodontics Calibration Kit. July, 2000

CASE MB

A female non-extraction case, aged 12.11 years, with a high-angle pattern (MM 37°).

Molar relationship was 4 mm Class II on the right and 2 mm Class II on the left. All the teeth were developing normally, except the upper left third molar. Arch form was assessed as ovoid. It was decided to manage the case on a non-extraction basis, with upper anterior torque and lower incisor enamel reduction.

Standard metal brackets were used with .016 HANT wires to commence tooth alignment. The patient was asked to wear a combination headgear during evenings and nights. Lower enamel reduction was delayed until correct upper and lower incisor torque had been achieved, which would reveal the amount of reduction necessary.



Fig. 10.23



Fig. 10.26

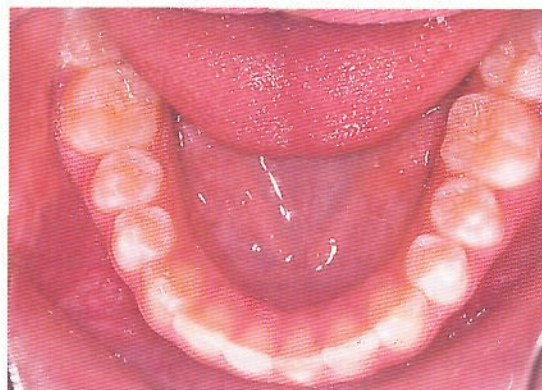


Fig. 10.29

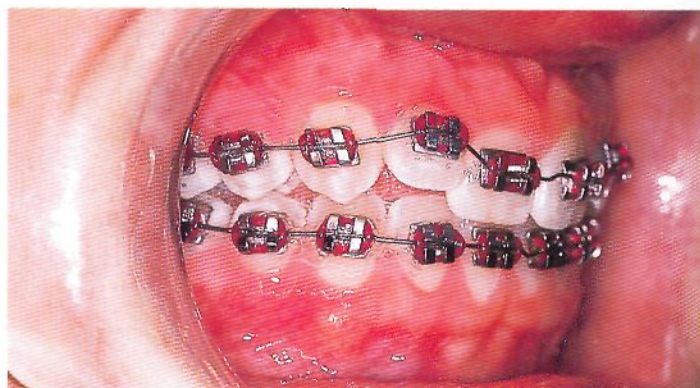
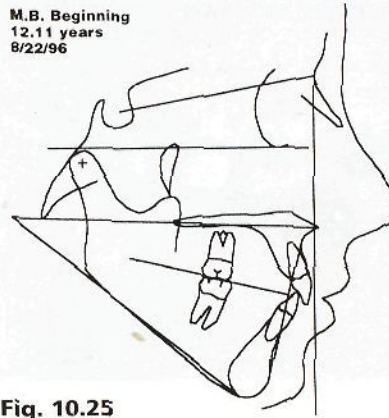


Fig. 10.32



Fig. 10.24

M.B. Beginning
12.11 years
9/22/96



SNA $\angle$ 75°
SNB $\angle$ 71°
ANB $\angle$ 4°
A-N $\perp$ FH -5 mm
Po-N $\perp$ FH -16 mm
WITS 0 mm
GoGnSN $\angle$ 50°
FM $\angle$ 39°
MM $\angle$ 37°
 $\frac{1}{1}$ to A-Po 7 mm
 $\frac{1}{1}$ to A-Po 3 mm
 $\frac{1}{1}$ to Max Plane $\angle$ 98°
 $\frac{1}{1}$ to Mand Plane $\angle$ 84°

Fig. 10.25



Fig. 10.27

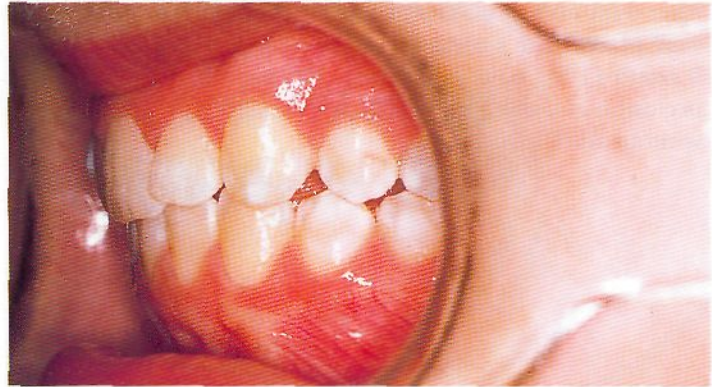


Fig. 10.28

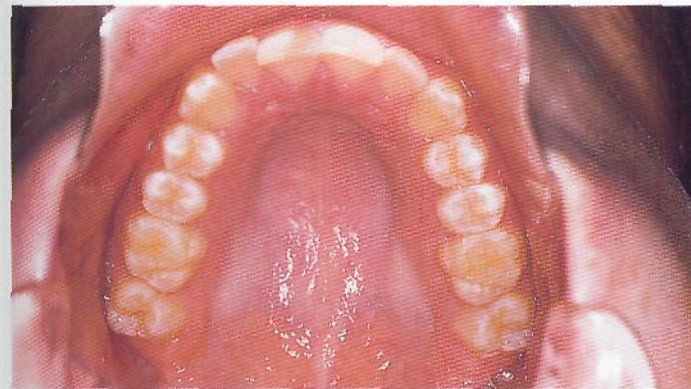


Fig. 10.30

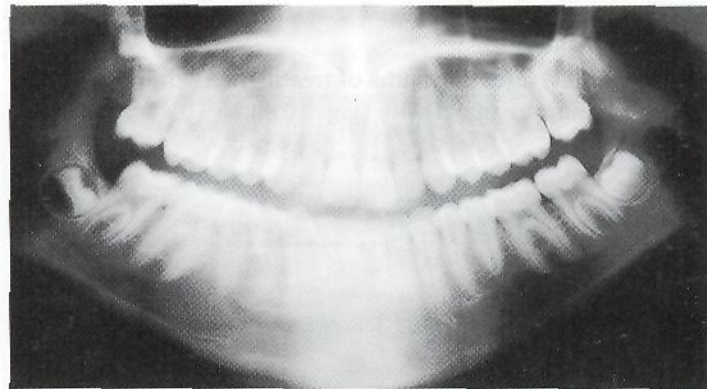


Fig. 10.31

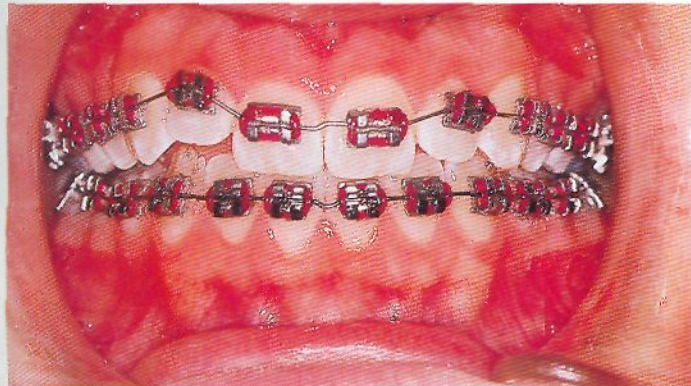


Fig. 10.33

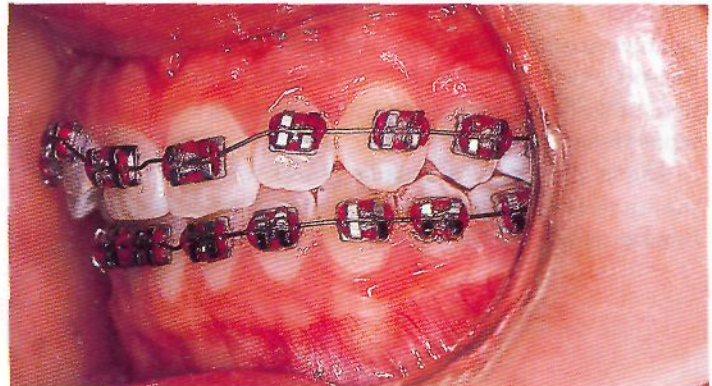


Fig. 10.34

After 3 months of treatment, upper and lower rectangular HANT wires are in place.

After 6 months of treatment, steel .019/.025 rectangular wires were placed. The patient was asked to wear a right side Class II elastic (100 gm) to commence correction of the right side occlusion and the midlines. Archwires were placed flat, without additional torque.

Subsequently, after 9 months of treatment, additional torque was added to the upper wire (Figs 10.41 to 10.43, and 10.46).

It became clear that lower enamel reduction was needed. Separation and then enamel reduction (Fig. 10.46) of lower incisors was carried out after 10 months of treatment, and first molar bands and upper canine brackets were repositioned.

Upper and lower rectangular HANT wires were used for 1 month to re-level and align after enamel reduction and bracket repositioning,

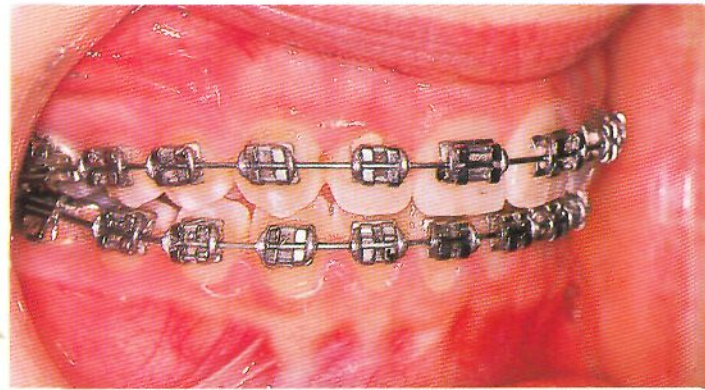


Fig. 10.35

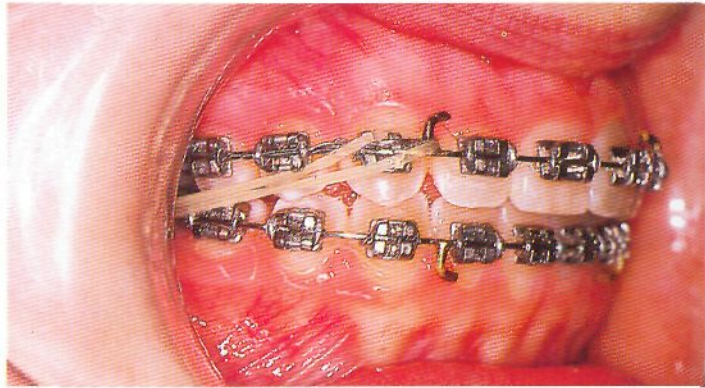


Fig. 10.38

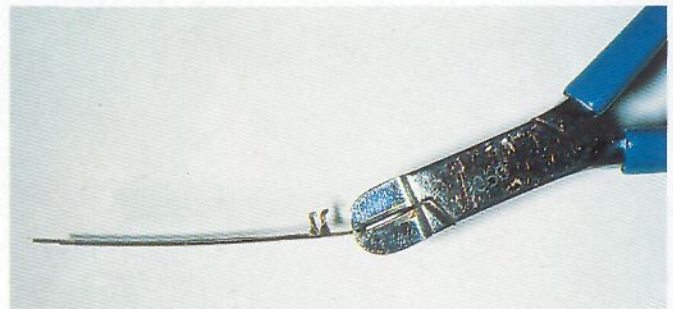


Fig. 10.41

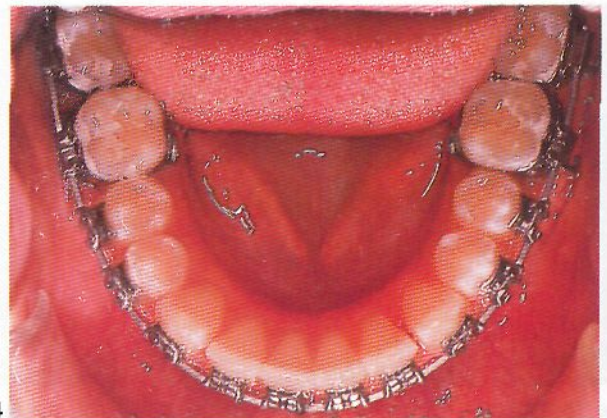


Fig. 10.44

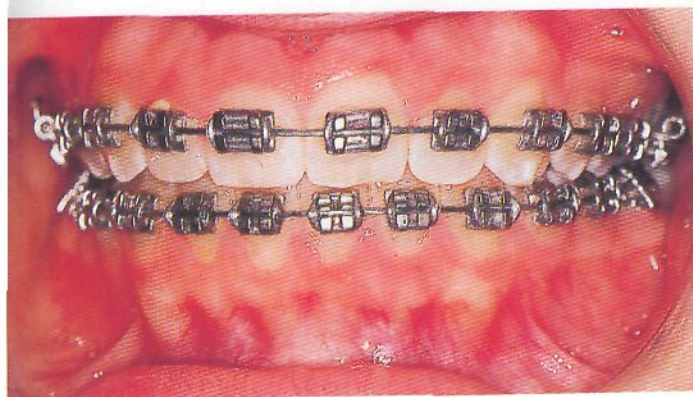


Fig. 10.36

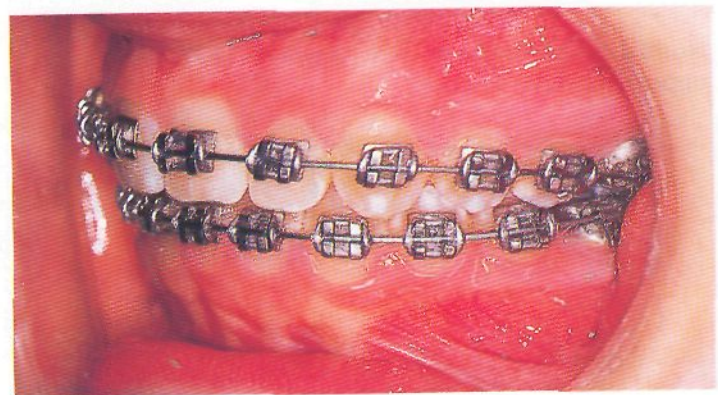


Fig. 10.37

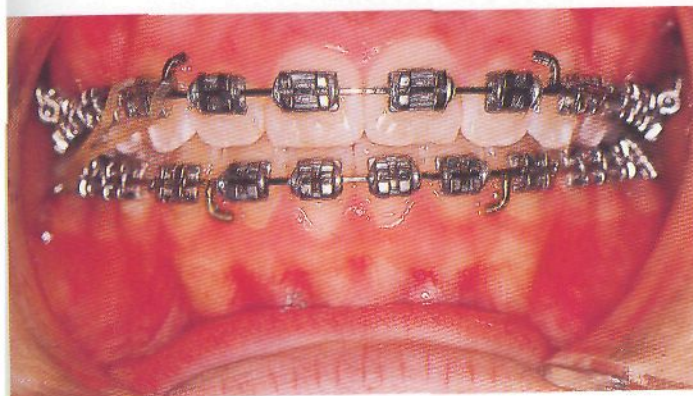


Fig. 10.39



Fig. 10.40

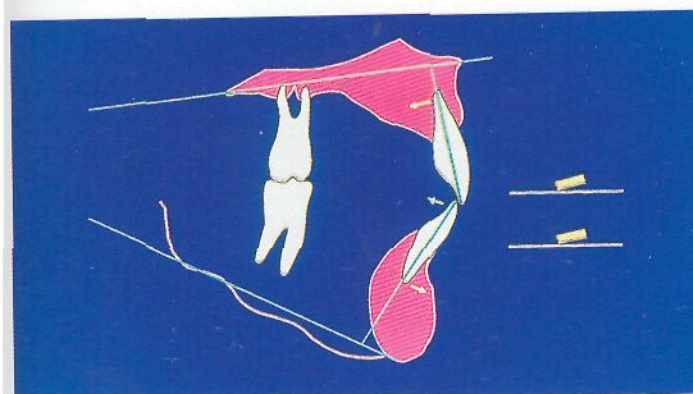


Fig. 10.42

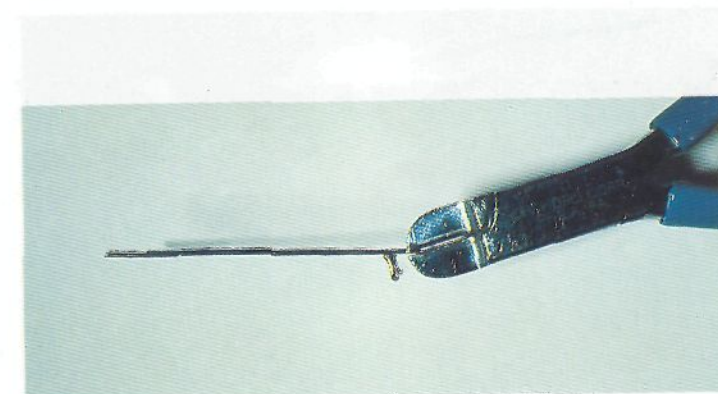
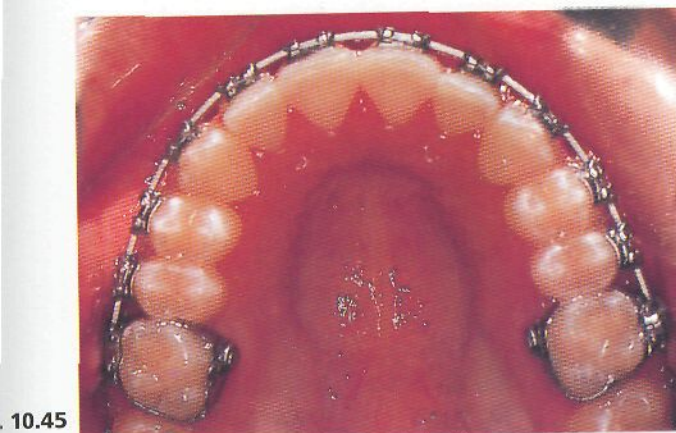


Fig. 10.43



10.45

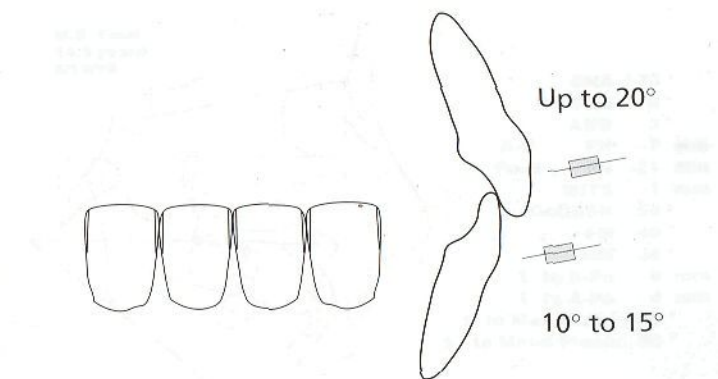


Fig. 10.46

Normal settling methods were used, with lower bonded and upper removable retainers.

The case after appliance removal. Active treatment time was 15 months.



Fig. 10.47

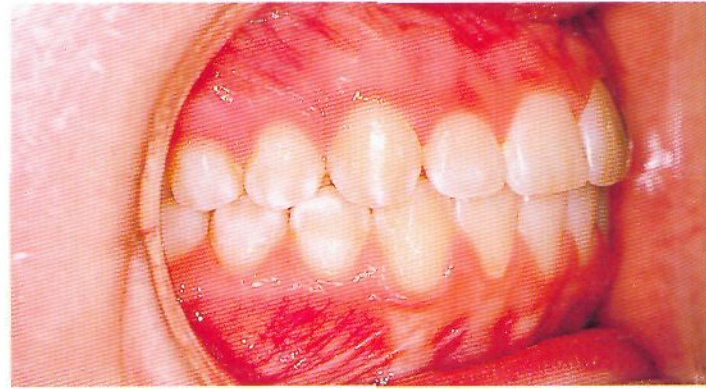


Fig. 10.50

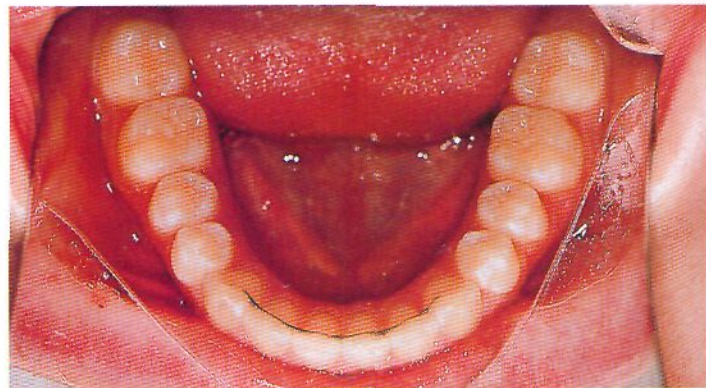


Fig. 10.53



Fig. 10.56



Fig. 10.48

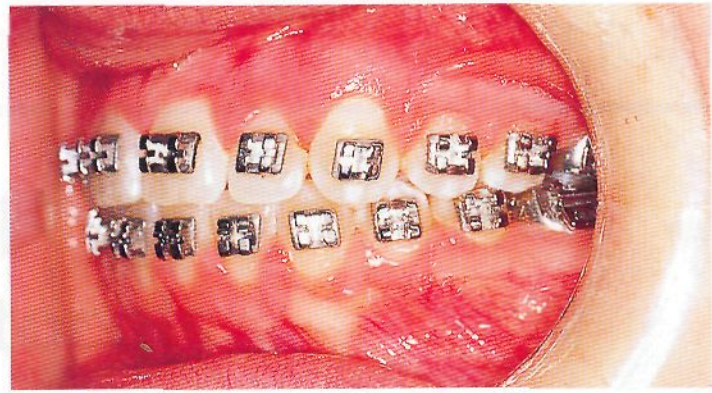


Fig. 10.49



Fig. 10.51



Fig. 10.52



Fig. 10.54

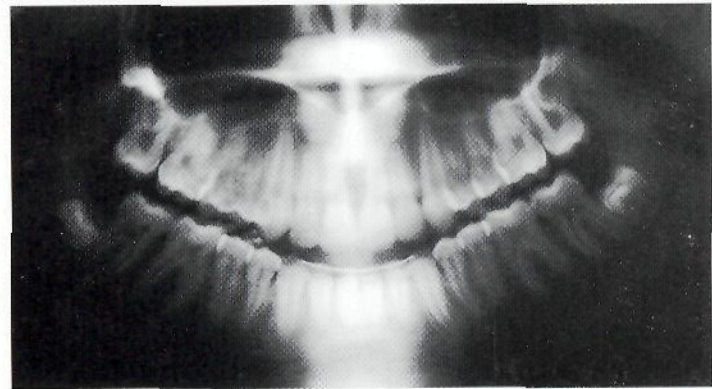


Fig. 10.55



Fig. 10.57

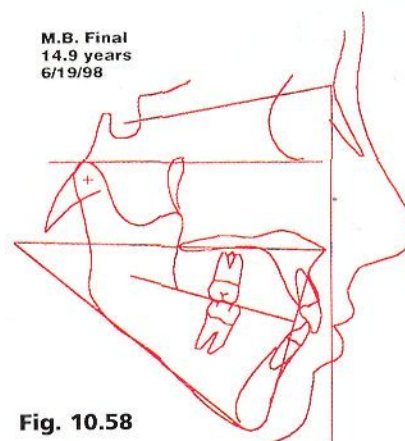


Fig. 10.58

M.B. Final
14.9 years
6/19/98

SNA / 73°
SNB / 70°
ANB / 3°
A-N — FH -7 mm
Po-N — FH -21 mm
WITS -1 mm
GoGnSN / 50°
FM / 40°
MM / 38°
1 to A-Po 8 mm
1 to A-Po 4 mm
1 to Max Plane 105°
1 to Mand Plane 90°

CHAPTER 11

Appliance removal and retention protocols

Introduction 307**Preparation for appliance removal – the final adjustment appointment 308**

All-at-one-visit appliance removal 308

Progressive appliance removal 308

The appliance removal appointment 309

Bracket removal – metal brackets 309

Bracket removal – ceramic brackets 309

Band removal 310

Removal of remaining cement and bonding agents 310

Footprints from bonding agents 310

White spots 310

Positioners 311

Positioner construction 311

Bonded retainers 312

Lingual bonded retainers 312

Palatal bonded retainers 312

Labial bonded retainers 313

Removable retainers 314

Conventional wire and acrylic 314

Vacuum-formed 315

Post-treatment protocol 316

Post-treatment consultations 316

Patient letters 316

Long-term retention considerations 317

Upper arch 317

Lower arch 317

INTRODUCTION

Wherever possible, routines and standard approaches should be introduced into orthodontic practice. This systemized approach cuts down the day-to-day decision-making and improves efficiency. This statement applies to all aspects of orthodontics, including retention. It is essential to have a good retention protocol.

The authors routinely place a lingual bonded retainer in the lower arch for most of their patients (Fig. 11.1), although they accept that not all patients need this. Some lower labial segments would remain straight without the use of a bonded retainer, but it is not possible to know which cases belong in *this category*.

This approach has the disadvantage that some patients will have retainers needlessly, just as they may have insurance, but never use it. However, this policy does at least avoid lower incisor crowding or relapse during late adolescence. Such late changes are greatly disappointing to patients, and come at a time when they are not receptive to further treatment (Fig. 11.2). Late changes are also quite demanding on practice resources and undermine efficiency.

Reitan¹ showed that the periodontal ligament needs at least 232 days to re-organize after tooth movement, and the elastic supra-crestal fibers need 1 year. There is a clear need to retain the result against the orthodontic relapse tendency, and against changes caused by late unfavorable growth. Retention protocol is an individual choice for each orthodontist, and there will be differing views concerning how rigid it should be. But a policy should be created and adhered to.



Fig. 11.1 A .015 bonded spiral wire retainer in place after non-extraction treatment. The authors routinely place lingual bonded retainers for most of their patients.

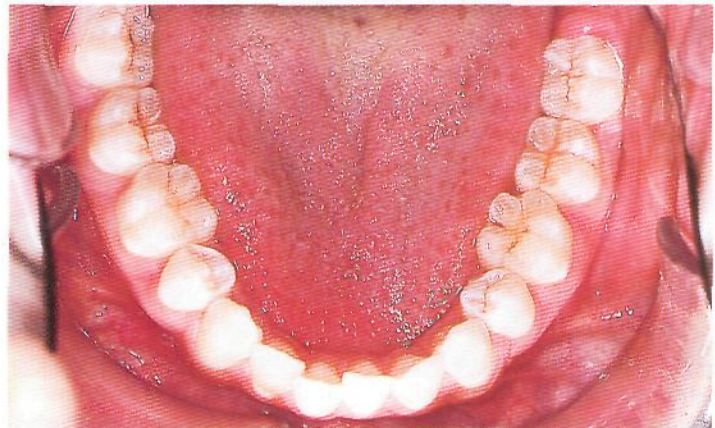


Fig. 11.2 This first premolar extraction case showed lower incisor relapse at age 18, and required further treatment to realign the lower anterior segment. A lingual bonded retainer would have prevented the relapse.

PREPARATION FOR APPLIANCE REMOVAL – THE FINAL ADJUSTMENT APPOINTMENT

Before making arrangements for appliance removal, it is necessary to ensure that treatment has been completed. All the recommended checks in finishing and detailing (Ch. 10, p. 279) should be carried out at the final adjustment appointment.

Spaces can sometimes appear late in the treatment. Tie wires or very light elastic chain (p. 286) should be placed at the final adjustment appointment to maintain tight tooth contacts. This will avoid patient disappointment, and ensure that the long appointment can be used for appliance removal, as planned. If ligature wires, instead of elastomeric modules, are used to attach the archwires at this final adjustment visit, bracket removal may be easier at the next appointment (p. 309).

The patient should be informed and reassured about procedures at the forthcoming appliance removal appointment. Because it will be a long procedure, with laboratory time involved, they should be asked to try not to re-schedule it. The patient should also be asked to arrange to see the family dentist for a routine check-up, but not until at least 4 to 6 weeks after removal of the fixed appliance. This will allow settling and gingival improvement.

It is necessary to take an impression of the lower anterior teeth at this appointment, to allow laboratory preparation of the multistrand wire. If there are deposits on the lingual aspects of the lower incisors, it is correct to carry out thorough cleaning and polishing at this appointment. This gives a more accurate laboratory model. Also, at the subsequent appliance removal appointment, this will reduce the amount of cleaning needed, and hence the amount of oozing.

In a few cases, for a variety of reasons, the orthodontist may agree to removal of appliances before completion of tooth movements. Such cases may have a greater tendency for relapse, and many orthodontists ask the patient to sign a release statement, acknowledging early appliance removal. This confirms that the patient has been informed that the treatment has not been completed, and that further improvement could be achieved.

All-at-one-visit appliance removal

It is normally preferable to remove all the orthodontic appliances at one visit. This is most convenient for the patient, and efficient in terms of practice scheduling, because the appliance removal and polishing instruments only have to be laid out on one occasion. Also, it is normally necessary for the orthodontist to retain control of both arches until the completion of tooth movements. Partial debonding can leave certain teeth unretained and subject to unwanted movement.

This appointment should be the high point of the orthodontic treatment for the patient. Scheduling a long morning appointment will allow an unhurried approach to appliance removal. There will be adequate time for discussion and instruction concerning retention, and for the orthodontist and patient to enjoy the moment.

Progressive appliance removal

In some situations, it may be decided to gradually remove the appliances, over two or more visits. If one arch requires a lot less treatment than the other, for example, then it may be logical to consider early appliance removal in that arch. In some longer treatments, the patient may be glad to be offered early removal of upper appliances, in return for agreeing to a few more months of lower arch treatment.

Progressive appliance removal is recommended for adult treatments where bands are used, or where teeth were extracted. The terminal molar bands may be left in place and elastic chain or active tiebacks used to close band spaces elsewhere.

THE APPLIANCE REMOVAL APPOINTMENT

Bracket removal – metal brackets

A debracketing instrument (3M Unitek 444-761) or old ligature cutters are used to remove metal brackets (Fig. 11.3). When using the debracketing instrument, if the archwires are held in place with tie wires, the brackets can be detached from the tooth surfaces without first taking out the archwires. The archwire may then be removed with the brackets attached to it (Fig. 11.4), avoiding the possibility of loose brackets in the mouth. When using old ligature cutters, archwires may be removed with the brackets attached if tie wires or elastomeric modules are in place.



Fig. 11.3 A special debracketing instrument or old ligature cutters can be used to remove metal brackets.



Fig. 11.4 If the archwire is removed with the brackets attached to it, this avoids the possibility of loose brackets in the mouth.

Bracket removal – ceramic brackets

Ceramic Clarity™ brackets are removed using a different technique. Archwires need to be taken out first, and any excess bonding agent removed from around the brackets, using a high-speed flame-finishing bur (Fig. 11.5). Each bracket may then be collapsed by gripping it mesially and distally using band-seating pliers and squeezing (Fig. 11.6). It can help the confidence of nervous patients, or those with slightly mobile teeth, if they use each anterior tooth in turn to firmly bite on to a cotton roll at the time of bracket removal.

On the rare occasions when a ceramic bracket does not fully detach itself from the tooth surface, it is necessary to remove the remains using high-speed diamond instruments, copious amounts of water, and high-volume suction.

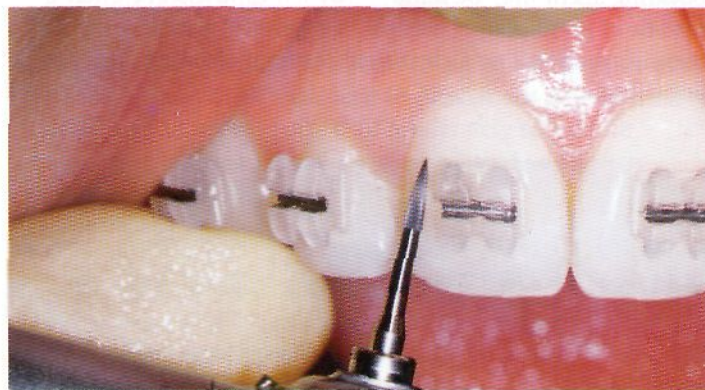


Fig. 11.5 It is correct to remove any excess bonding agent before removing Clarity™ brackets.

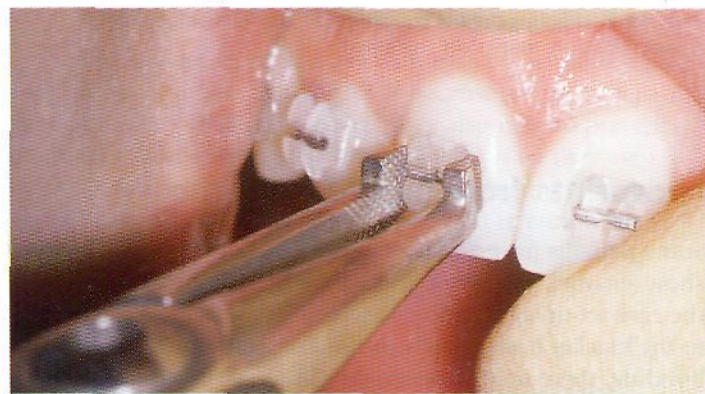


Fig. 11.6 Band-seating pliers (3M Unitek 900-711) are used to collapse the Clarity™ bracket by squeezing mesio-distally, so that it closes like a book. The pliers are applied approximately 1 mm away from the tooth surface.

Band removal

Band removal pliers can be used to easily remove most molar bands. Lifting from the disto-gingival aspect is normally effective. Only rarely is it necessary to use a high-speed drill to cut the band material.

Removal of remaining cement and bonding agents

After detachment of all the bands and brackets, the remaining cement may be removed using scalers or band-removal pliers, and then high-speed flame-finishing burs, without a water spray. Teeth may be polished using conventional rubber cups and pumice or a proprietary polishing agent. In instances where there is considerable gingival enlargement at the time of appliance removal, part of the residual cement and bonding agent may be temporarily left on the teeth. After a month of good plaque control, the gingival condition will then normally allow a clear field for final cleaning and polishing.



Fig. 11.7 It is important to minimize the possibility of decalcification marks on the teeth.

Footprints from bonding agents

Some patients have a fluorotic type of enamel, and they may show 'enamel footprints' at the time of appliance removal. At the case set-up appointment etchant is normally applied only to the bracket base area. At the end of treatment, after debonding, there may be residual resin in the previously etched area of enamel, with an appearance which contrasts with the fluorotic enamel. This 'bracket base area' may have a better appearance than the untreated enamel. For this reason it might be considered logical to etch the entire labial surface for some patients with fluorotic enamel, at the time of case set-up. This is currently being investigated.

White spots

Decalcification spots on the teeth can be most disappointing to orthodontist, patient, parents, and referring dentist (Fig. 11.7). The finger is often pointed towards the orthodontist concerning the cause of the problem. While this is generally not the case, if the patient's attention to oral hygiene early in the treatment is poor, it is important to minimize this problem. A suggested protocol can be considered and explained to the patient, in letter form, pre-treatment.

- At the first visit that poor oral hygiene is noticed, the patient is informed of the condition and told that if there is no improvement by the following visit, wires will be removed.
- The patient can then be checked briefly at 2 to 3 week intervals until there is improvement, which is usually the case.
- If no improvement occurs after two to three visits without archwires, the anterior brackets can be removed until there is improvement. This is rarely needed, if proper limits are set.
- If there is still no response, then removal of the appliances or transfer to another orthodontist is recommended. This is rare indeed.

The causes of local enamel decalcification are multifactorial.^{3,4} Good oral hygiene is important, but there is also individual variation in plaque type and composition. Some patients will have a greater risk of local changes in ecological balance, leading to decalcification.

It is not possible to identify those individuals who are predisposed to local decalcification, but it is clear that a small group of patients is responsible for a large percentage of the affected teeth. For some patients it may be helpful to advise one or two weeks of additional rinsing with proprietary 0.2% chlorhexidine rinse, according to the manufacturer's instructions. This may help to favorably change the bacterial flora and restore ecological balance.

POSITIONERS

A high percentage of cases can be well treated without the need for tooth positioners. However, they can be useful in the following situations:

- For patients who have shown excellent cooperation and who want ideal settling, with the best possible result. Many patients become tired towards the end of treatment, and are not able to cooperate fully in normal finishing and detailing procedures.
- For patients with persistent anterior or posterior tongue habits. A properly constructed positioner can have a bite-closing effect.
- In some treatments, it is necessary to remove the appliances early, for a variety of reasons. Further improvement can be obtained for these patients if they will wear a positioner, but sufficient cooperation is seldom forthcoming!

Positioners can be used at the completion of orthodontic treatment to allow for ideal settling of the occlusion. Major tooth movements such as torque control, significant rotation, and tip control are not possible. Minor settling movements, including tipping and rotation, can be carried out if cooperation is reasonable.

The major obstacle to the success of positioners is patient cooperation. Patients are often tired at the end of orthodontic treatment and are not willing to put in the additional time and effort to wear a positioner. If it is planned to use a positioner, it is best to explain this to the patient at the beginning of treatment. Therefore, offices that use positioners frequently, generally inform their patients before treatment, and achieve a better overall response than those that suggest a positioner at the very end of treatment.

Positioner construction

The technique for positioner construction is as follows:

- Complete the case as well as possible through the settling stage.
- With brackets on, take two sets of upper and lower impressions. One set is used for a reference, and the second set is used for positioner construction.
- Take a face bow recording and a centric relation wax bite, followed by mounting of the case on an articulator. This is critical so that the axis of opening is correct and the positioner material between the teeth is the right thickness both anteriorly and posteriorly.
- Continue detailing the case as needed while the positioner is being constructed.
- The laboratory can be instructed to set all the teeth or to just set certain teeth that need improvement. The normal positioner materials consist of moderately soft white rubber, soft clear material, or material that will soften when heated and harden when brought to mouth temperature.
- When the positioner arrives, all orthodontic appliances can be removed and the positioner placed. There are generally two options concerning positioner wear:
 - wearing the appliance as much as possible for 2 weeks, followed by night wear for a month and then placement of retainers
 - using the positioner as a retainer for a more extended period of time.

Positioners are most effective with patients who presented with an open-bite tendency. This is because positioners in general have a bite-closing effect. They also help to prevent the tongue from causing tooth movement when they are worn. Conversely, cases that begin initially with a deep bite are not best suited for a positioner; normal retention is probably a better option.

BONDED RETAINERS

Lingual bonded retainers

The authors provide a lower canine-to-canine lingual bonded retainer for almost all patients at the end of treatment. In first premolar extraction cases, this is normally extended on to the mesial fossae of the second premolars. The multistrand wire may be .015 or .0195, and it is bonded using Transbond LR™, with a meticulous technique. The wire can be made at the chairside, but greater accuracy and adaptation are possible if it is made on a model in the laboratory.

Careful cleaning of the lingual surfaces of the teeth is needed – much more than on the labial surface. A meticulous technique needs to be followed when bonding lingual or palatal retainers, ensuring a perfectly dry field. As an alternative to conventional isolation with cotton rolls, the following technique can be considered. A rubber dam can be placed to isolate the area. Orthodontists or their assistants may be resistant to the use of a rubber dam, because of the small amount of additional time required. However, with some experience, the procedure goes smoothly and quickly, with less potential for moisture contamination. Micro-etching can be used at low pressure and for a short time for initial cleaning. This cannot be considered as a substitute for acid etching,² which should be carried out in the normal way with 37% phosphoric acid for 20 to 30 seconds. Thorough rinsing and drying are then essential. Care is taken not to move the wire during bonding, and adequate light is used. Few breakages occur.



Fig. 11.8 The Transbond LR™ material may be taken from the dispensing syringe onto a hand instrument.

Palatal bonded retainers

These are not used as frequently as lower lingual retainers, because of the potential for breakage due to occlusal contact, or contact during biting. However, they are essential to ensure good retention of many adult cases, because some patients experience persistent spacing (especially in the midline) or other upper incisor movements. The advantages of palatal bonded retention outweigh the potential risk of breakage in such cases.

Before placement, the patient's overbite and overjet should be evaluated. Care should be taken to place the wire away from the area of contact. A multistrand wire of size .015 to .0195 can be used, and placed in a manner similar to the lower bonded retainer (Figs 11.8 & 11.9). The patient should be asked to be careful with this wire, in order to avoid breakages. With proper care, they can remain in place for a long time.

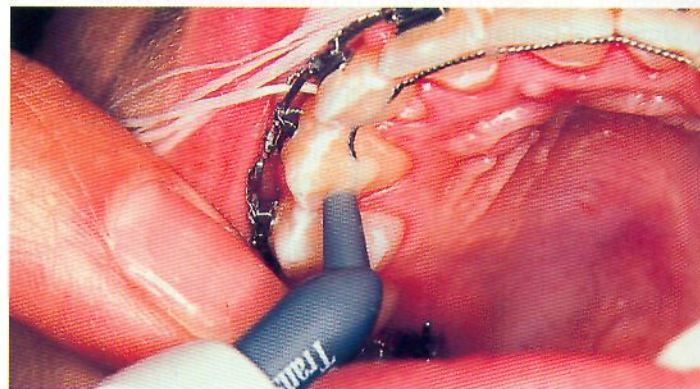


Fig. 11.9 Alternatively, the bonding material may be applied directly from the syringe, and this is normally the preferred method.

Labial bonded retainers

Bonded labial retainers for upper incisors are increasingly being considered. This may be useful as a short-term measure for impatient adults, allowing earlier removal of brackets. After a few months with a labial bonded retainer, more

conventional methods can be used for retention. In adolescent treatment, labial bonded retainers can be useful in a 'pause' phase, while awaiting eruption of more teeth (Fig. 11.10).



Fig. 11.10A and B This Class II/2 malocclusion was treated to achieve initial alignment over a 9 month period.

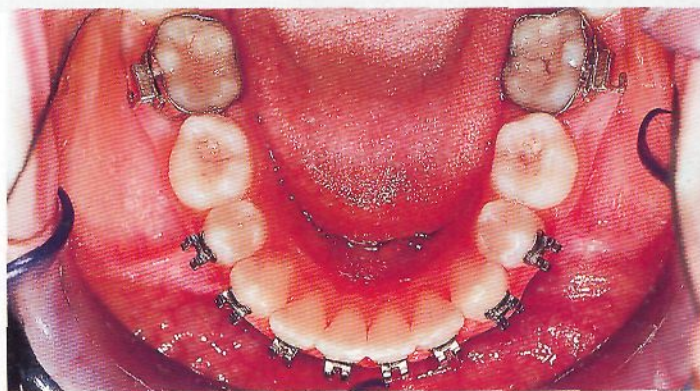
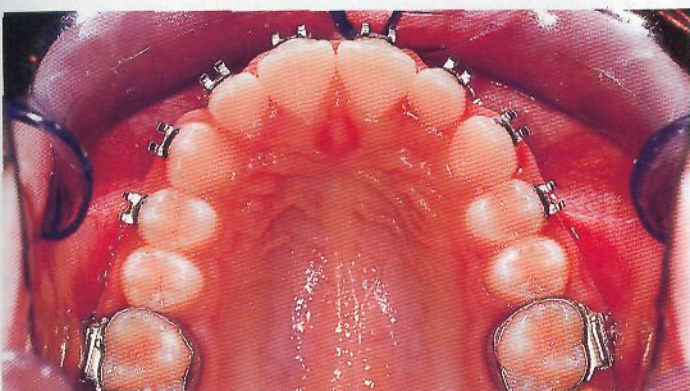


Fig. 11.10C and D It was necessary to pause to allow extraction of lower second primary molars and eruption of the lower second premolars.



Fig. 11.10E and F The bonded brackets were removed, and an upper labial bonded wire was placed to stabilize the improvement. Molar bands were left in place. After a 6-month pause, and following the necessary primary tooth extractions and eruption of the lower second premolars, it was possible to resume the treatment. During the pause, there was spontaneous improvement amongst the buccal occlusion, and minimal patient cooperation was required with retention.

In other cases, it may be helpful to provide local bonded labial retention for a few teeth, in addition to vacuum-formed retainers. For example, this is helpful after correction of severely rotated teeth or palatally placed canines (Fig. 11.11), which have a high probability of relapse, and which are not well retained using only Hawley or vacuum-formed retainers.

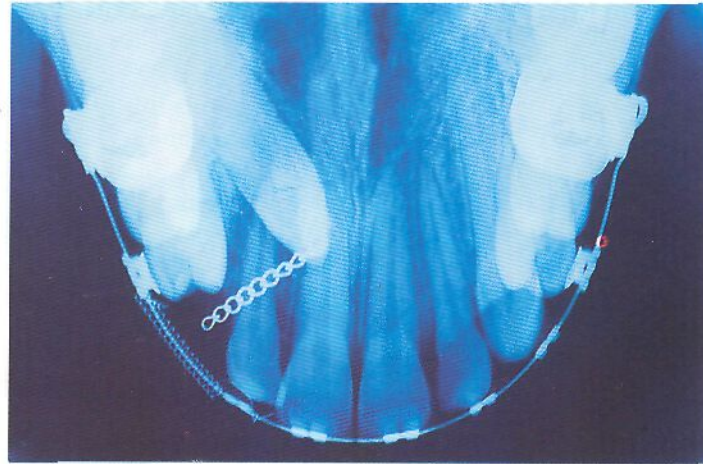


Fig. 11.11 After correction of palatally positioned permanent canines, it is helpful to place a local bonded labial retainer, in addition to conventional upper removable retention. Such teeth have a strong probability of relapse, and removable retention is seldom adequate.

REMOVABLE RETAINERS

Conventional wire and acrylic

Wire and acrylic removable retainers can be useful in the conventional 'wrap-around' or Begg type, for maintaining space closure after extractions, or as a Hawley type in deep-bite cases (Figs 11.12A & B) where the upper retainer needs to carry a bite plane.

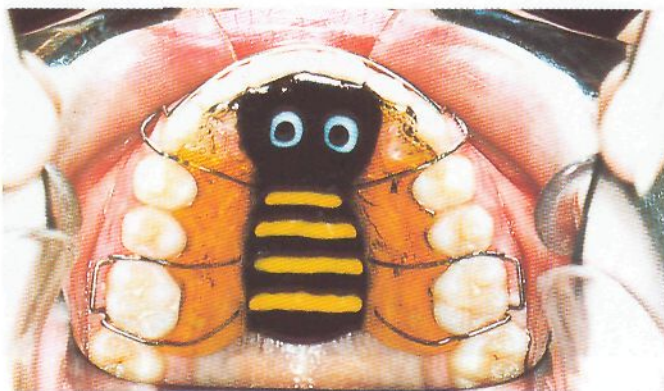


Fig. 11.12A Acrylic Hawley retainers can be useful when retaining deep bite cases.

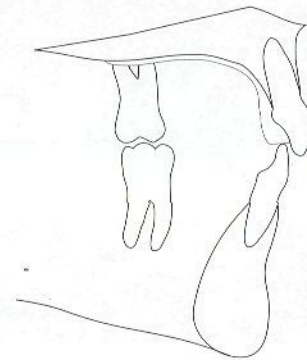


Fig. 11.12B Hawley retainers can be constructed with a bite plane to assist in retention of deep-bite cases.

Vacuum-formed retainers

Vacuum-formed retainers have many advantages over wire and acrylic for most patients needing removable retainers. They are rapid and economical to make, require no adjustment, and, if well made, are easy, comfortable, and esthetic to wear. Due to their greater accuracy, concerns have been expressed that they may slow the settling process. However, many orthodontists report that this is not as great a problem as might be expected.

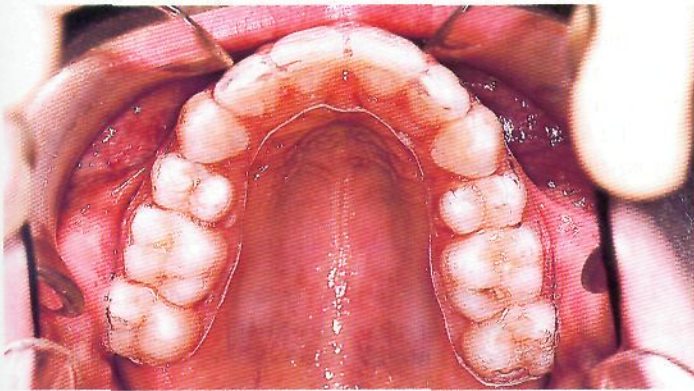
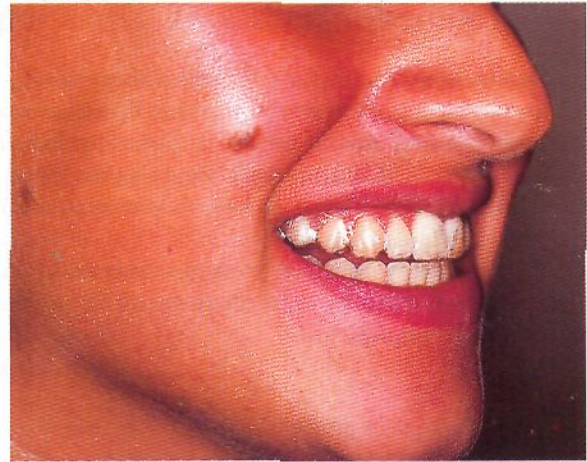


Fig. 11.13 Vacuum-formed retainers are rapid and economical to make, and are comfortable and esthetic to wear.

POST-TREATMENT PROTOCOL

Post-treatment consultations

Many orthodontists find it helpful to have a short post-treatment consultation. At this visit, it is possible to review the initial problem and final results. It is quite surprising how patients can forget the details of their beginning problem. Refreshing their memories leads to happier patients and more referrals!

Since the availability of digital imaging systems such as Dolphin™ Imaging, it has become relatively quick and easy to provide before and after pictures.

Patient letters

A few days after removal of fixed appliances, it is helpful to send a standard letter to the patient. This can help to reduce the stress and workload for the orthodontist during the retention phase. A second letter can be sent 1 year later.

The first letter emphasizes the importance of the retention phase of the treatment (regarded by many orthodontists as a major challenge) and can support the post-treatment consultation. Suggested text for the first letter can be as follows:

Dear

Congratulations on the recent successful completion of the active phase of your orthodontic treatment. Now that the fixed appliances have been removed, we are ready to begin the retention phase. The teeth and tissues have not completely adjusted to their new positions yet, and retainers are necessary to hold the teeth in their new positions, allowing for settling of the supporting tissues.

The fees included provision of a set of retainers and their maintenance over a 1-year period. If it is necessary to continue retention supervision beyond that point, appointments will be charged on a per visit basis. We recommend that you see your general dentist for a thorough dental check-up about 4 to 6 weeks after removal of the fixed appliances.

We look forward to continuing your successful orthodontic treatment during the retention period, and to seeing you again in due course for your next retainer check. If you have any questions, please let us know.

Yours sincerely

After 1 year of retention, a second standard letter can be sent. Both letters remind the patient that the quoted fee covered only the active phase of treatment and 1 year of retention. Text for a second letter can be as follows:

Dear

I am pleased to confirm that your supervised retention program has now concluded, and you no longer need to see us on a regular basis. You should continue to wear your retainers, as advised, in order to maintain the best results; conscientious, long-term wear should ensure lasting stability of the improvement.

If you wish to make future appointments, either for a general orthodontic check-up, or if you have any difficulties with your retainers, we will be glad to help. A charge will be made for such visits. Please do not hesitate to contact us should you require advice or support in any way.

I'd like to take this opportunity to stress the ongoing need for your regular reviews with your general dentist in order to maximize the result we have achieved.

Yours sincerely

Two versions of these letters are necessary, depending on whether the patient is a child or an adult. They are kept on disc, of course, and are modified or made more personal as necessary.

It has been reported by Bishop⁵ that an Australian physician, Dr M.H.N. Tattersal, found that follow-up letters greatly improved the patient perception of the service he had provided. 'Totally satisfied' – the highest rating – was reported by 54% of those who received letters, compared with only 16% who did not!

LONG-TERM RETENTION CONSIDERATIONS

The protocol concerning long-term retention varies greatly among orthodontists. Also, the level of cooperation among patients after treatment may vary even more! Some orthodontists^{6,7} believe that if beginning arch form (especially inter-cuspid width) is preserved, contact points are flatted for stability, and fiberotomies are carried out where needed, that little or no retention is necessary. Other work^{8,9} suggests that if teeth are to remain in position, permanent retention is needed. While each of these possible approaches may be satisfactory in certain cases, they may not be appropriate for others. Each orthodontist will establish a protocol, and the following 'middle of the road' approach might be a useful basis for decision making.

Upper arch

As the majority of relapse in the upper arch occurs within the first 6 months, the patient can be requested to wear a removable retainer full time, or as often as possible. After this, the patient can gradually go to night-time hours, while being observant of pressure areas that may occur. If these occur, longer retention may be necessary. Eventually, the patient may move towards no upper retention.

Lower arch

The lower anterior segment has long been considered the 'foundation of the house', especially during the later stages of growth and development. The lower bonded retainer can therefore be left in place until growth is complete in young patients, and for approximately 2 years in adults. After this, case-by-case decisions can be made concerning removal.

REFERENCES

- 1 Reitan K 1959 Tissue rearrangement during retention of orthodontically rotated teeth. *Angle Orthodontist* 29:105-113
- 2 Van Waveren Hogervorst W L, Feilzer A J et al 2000 The air abrasion technique versus the conventional acid-etching technique: a quantification of surface enamel loss and a comparison of shear bond strength. *American Journal of Orthodontics and Dentofacial Orthopedics* 117:20-26
- 3 Mitchell L, 1992 Decalcification during orthodontic treatment with fixed appliances – an overview. *British Journal of Orthodontics* 19:199-205
- 4 Twetman S, Hallgren A, Peterson LG, 1995 Effect of an antibacterial varnish on mutans streptococci in plaque from enamel adjacent to orthodontic appliances. *Caries Research* 29:188-91
- 5 Bishop J E 1991 Technology and medicine; doctors get results by sending letters after treatments. *Wall Street Journal* October 11:134
- 6 Boese L R 1980 Fiberotomy and reproximation without lower retention, nine years in retrospect: part 1. *Angle Orthodontist* 50:88-97
- 7 Boese L R 1980 Fiberotomy and reproximation without lower retention, nine years in retrospect: part 2. *Angle Orthodontist* 50:159-178
- 8 Little R M, Reidel R A, Årtun J 1988 An evaluation of changes in mandibular anterior alignment from 10 years to 20 years postretention. *American Journal of Orthodontics and Dentofacial Orthopedics* 93:423-428
- 9 Little R M, Wallen T R, Reidel R A 1981 Stability and relapse of mandibular anterior alignment – first premolar cases treated by traditional edgewise orthodontics. *American Journal of Orthodontics* 80:349-365

Index

- Acrylic bite plates 135, 171
 Acrylic retainers 83, 314
 Adenoids removal 143, 144
 Aligning *see* Leveling and aligning
 Analgesics 112
 Anchorage control 94
 antero-posterior 100–106
 Class II treatment 172, 173
 definition 94
 lateral (coronal) plane 108
 MBT bracket system 15
 principles 94
 recognizing needs 96–97
 reduction of needs 99
 space closure 250, 260–262
 vertical 106–107
 Andrews' bracket system 4–5, 27
 Anterior bite plates 134, 135
 Anterior open bite 142–144
 development 142
 early management 143
 elimination of environmental factors 142
 management during full orthodontic treatment 144
 skeletal cases 142
 Anterior tip values 4, 8, 9
 MBT bracket system 9, 15
 Antero-posterior anchorage support 100–106
 bendbacks 102–103
 Class III elastics 104
 headgear 104, 105
 lacebacks 100–101
 lingual arches 104
 palatal bar 106
 APC brackets 69
 APO line 168
 Arch form 72–84
 asymmetries 82
 canine bracket selection 45
 classification 74
 clinical issues 73
 control
 early treatment 77
 rectangular HANT wires 78
 rectangular steel wires 78
 customization 72
 customized wires 77, 84
 finishing 83, 289
 'ideal' 72, 73
 McLaughlin and Bennett treatment approach 7
 MBT bracket system 12, 16
 modifications 80–82
 after maxillary expansion 80
 posterior torque considerations 80
 ovoid 12, 16, 74, 75, 76, 77, 78, 289
 practical aspects 74–76
 recommended ratios 75
 retention 83
 square 12, 16, 74, 75, 76, 77, 78, 81, 289
 stability/relapse following treatment-related change 72, 73
 standardized wires 77
 Straight-Wire Appliance (SWA) 4
 tapered 12, 16, 74, 75, 76, 77, 78, 289
 templates
 clear 77
 wax 289
 variability 73
 Archwire hooks 18
 MBT bracket system 18–19
 space closure with light forces 254
 turning in ends 112
 Archwires 13, 14
 bends 288, 295
 closing loop 252
 coordination 289
 customized 77, 78, 84
 adaptation to individual arch form (IAF) 78–79
 expansion technique 81
 finishing stages 20, 288
 flaming and quenching 103, 112
 forces *see* Force levels
 ligation methods 20
 opening 112
 plastic sleeving 112
 removal with brackets 308
 selection 3
 MBT bracket system development 12
 sequencing 110, 111
 settling phase 83, 294, 295
 space closure with light forces 254
 standardized 77
 stock control 77, 78, 84
 turning in ends 112
 upper arch expansion 81
 jockey arch use 82
 Arnett analysis
 Class II cases 163, 164–165, 168, 169
 Class III cases 220, 221
 dentoskeletal ideals 293
 Articulators 6
 Asymmetrical lower arch 82
 Bacterial endocarditis 69
 Bendbacks 7
 antero-posterior incisor control 102–103
 Class II treatment 171
 MBT bracket system 8, 15
 Bicuspid extractions, anterior open bite 144
 Bimaxillary protrusion 97
 Bimaxillary retrusion 97
 Bite-opening curves 137
 Bite-plate effect 134–135
 creation methods 135
 Bonded retainers 312–314
 labial 313–314
 palatal 312
 Bonding materials 57, 68, 69
 Bracket design 28–30
 anchorage needs reduction 99
 MBT bracket system 8
 see also Bracket system versatility
 Bracket positioning 3, 280, 281
 accuracy 13, 57, 59, 60, 61, 69
 anterior open bite 144
 axial 61
 bonding 68–69
 horizontal 60, 283, 284
 McLaughlin and Bennett treatment approach 7
 MBT bracket system 11, 13
 molar bands placement 66–67
 position for viewing teeth 59
 re-leveling procedures 109
 rotated incisors 61
 rotation control 285
 Straight-Wire Appliance (SWA) 4
 theoretical aspects 59
 vertical 61, 288
 bracket-positioning charts 61, 63–65
 use of gauges 61, 62
 Bracket system versatility 13, 39–54
 canine torque options 44
 interchangeable brackets
 lower incisor 48
 upper premolar 49
 main areas 39
 palatally displaced upper lateral incisors 40–43
 small upper second premolars 31, 52

Bracket system versatility, *continued*
tubes

- lower first molar double 53
- lower first molar non-convertible 53
- lower second molar, use for upper
 - first/second molars of opposite side 51
- lower second premolar 52
- second molar bondable mini tubes 54
- upper first molar triple 53
- upper second molar, use on first molars 50

Bracket-positioning chart 59, 61, 68

- individualized 63
 - abnormal incisal edges 64
 - deep-bite cases 65
 - lower first premolars 64
 - open-bite cases 65
 - premolar extraction cases 65
 - upper canines 64
- recommended chart 63

Brackets

- bonding 68–69
 - direct 68
 - indirect 69
- esthetic 28
- extraction series/translation series 252
- identification systems 28
- in-out specification 31
- removal
 - ceramic brackets 308
 - metal brackets 308
- rhomboidal shape 29
- selection 3, 13
- size range 28
- tip specification 32, 283
- torque specification 33–38
- torque-in-base 29
- upper second premolar 31, 52

'Burning anchorage' 262

Canines

- anchorage control
 - needs determination 96
 - vertical 107
- bracket design requirements 5
- bracket positioning 60, 62
- bracket selection determinants 44
 - arch form 45
 - overbite 46
 - premolar extraction cases 46
 - prominence 46
 - rapid palatal expansion 46
 - tip control 46
 - upper lateral incisor agenesis 47
- bracket-positioning chart individualization 64
- lacebacks 139, 140
 - antero-posterior control 100–101
- retraction in extraction deep-overbite cases 139–140
- torque 36
 - MBT bracket system values 10–11
 - options 44

Case reports

- Class I non-extraction 22–23
- mild Class II dentally 192–197
- tapered arch form with prominent canine roots 86–91

Class II

- adult, molar extractions 206–215
- deep bite, upper first premolars and all third molar extractions 184–191
- non-extraction 192
- non-extraction twinblock 198–205
- Class III 235–247
 - non-extraction, crowding 236–241
 - second molar extraction 242–247
- first premolar extraction 120–126
 - adult 264–271
 - maximum anchorage deep bite 146–151
 - space closure 264–277
 - non-extraction
 - average angle 114–119
 - deep bite 152–159
 - high angle requiring upper incisor torque and lower incisor enamel reduction 298–303

Case set up 57

- full 58
- partial 58
- patient management 57

Centric relation establishment 291

Cephalometric radiographs

- Class III cases 219, 220
- finishing 293

Ceramic bracket removal 308

Chin cap 233

- anterior open bite 143, 144

Chlorhexidine 69

Class I cases 162

- arch form 74
- high-angle 175, 176
- incisor torque 34, 176
- see also* Case reports

Class II cases 131, 162–183

- anchorage support 172, 173

arch form 74

- Arnett analysis 163, 164–165, 168, 169
- horizontal overcorrection during finishing 286, 287

incisor position 162

- lower 166
- treatment planning 162
- upper 166

incisor torque 34, 176

- major skeletal disproportion identification 164–165

molar position 162

- planned incisor position (PIP) 162, 166, 168–169

antero-posterior component 168

torque component 169

vertical component 169

positioning lower incisors 178–183

- change in A/P position of mandible due to condyle changes 178, 181, 182
- change in length of mandible 178, 180–181
- control of antero-posterior position 178
- functional appliances 181
- movement of incisors in mandibular bone 178, 179

- control of antero-posterior position 178
- functional appliances 181
- movement of incisors in mandibular bone 178, 179

treatment planning 166–167

- incisor position 162, 163
- mandibular growth prediction 180

- surgical/non-surgical decision 163, 164, 175

upper incisor movement 170–177

- cases with upper anterior spacing 172
- distal movement 172–173
- following upper premolar extractions 173
- mesial movement 170–171
- non-extraction cases without spacing 173
- torque control 174–176
- vertical control of maxilla 181
- vertical control of upper incisors 177
- see also* Case studies

Class II elastics

anterior open bite 144

archwire hooks 19

Class II treatment

- anchorage support 172, 173
- 'functional effect' 181

Class III treatment 225

space closure 262

Class II/1 cases 173, 178, 179

- anchorage control needs determination 96
- settling 83, 295

treatment planning 164–165

upper incisor movement 170, 172

Class II/2 cases 177, 178

- anchorage control needs determination 97
- canine bracket selection 46

mandibular inter-canine width stability

following treatment 72, 73

upper incisor movement 170, 171

Class III cases 131, 162, 219–234

- anchorage control needs determination 97
- arch form 74

Arnett analysis 220, 221

Class II elastics 225

Class III elastics 225, 230

horizontal overcorrection during finishing 286

incisor torque 34, 176

lower incisor movement 232–234

distal mandibular repositioning 233

mandibular growth restriction 233

retraction and retroclination 232

unfavorable Class III mandibular growth 234

mandibular displacements 219, 220

maxillary retrognathism 220

treatment timing 220

mechanics 225

planned incisor position (PIP)

components 228

upper incisor 226

posterior crowding in development 224

skeletal discrepancy evaluation 220

surgical/non-surgical decision 219, 220, 222–223

borderline cases 220

late mandibular growth 223

treatment planning 219, 220, 226–227

lower incisors 226

record-taking accuracy 219

upper incisors 226

treatment timing 220

upper incisor movement 229–231

excessive proclination 230

failure to achieve positive overjet 230

- mesial movement by proclination 229, 230
 mesial movement of maxillary bone 229, 231
see also Case reports
- Class III elastics
 anterior open bite 144
 archwire hooks 19
 Class III treatment 225, 230
 lower arch retraction 261
 lower molar antero-posterior control 104
 space closure 261
- Closing loop archwires 252
- Coil spring
 HANT/stainless steel wire use 111
 space closure with light forces 257–258
 space creation, palatally displaced upper lateral incisors 40, 42, 43
- Colored modules selection 112
- Computer-aided design/machining (CAD-CAM), bracket torque-in-base 29
- Contact point 288
- Copper nickel-titanium (heat-activated) wires
see HANT wires
- Coronal (lateral) anchorage support 108
- Crowding relief, premolar extractions 250, 251
- Curve of Spee 131
 final management 288
 leveling
 archwire placement response 134
 second molar banding/bonding 136
-
- Debracketing instrument 308
- Decalcification spots 310
- Deep-bite cases
 bracket-positioning chart individualization 65
 deep overbite development 131
 extraction treatment 138–141
 leveling and aligning 139–140
 space closure 141
 use of light forces 139–140, 141
 mandibular inter-canine width stability following treatment 72
 non-extraction treatment 134–138
 bite-opening curves 137
 bite-plate effect 134–135
 initial archwire placement 134
 intermaxillary elastics 138
 second molar banding/bonding 136
 spacing 138
 torque issues 136
partial case set up 58, 109
 tooth movements of bite opening 132–133
 distal tipping of posterior teeth 133
 eruption/extrusion of posterior teeth 132
 intrusion of anterior teeth 133
 proclination of incisors 133
 vertical overcorrection 289
see also Case reports
- Dentoskeletal structures evaluation during finishing 293
- 'Denture positioning' orthodontics 162, 219
- Digit sucking 142
- Displaced teeth
 bracket positioning 61
partial case set up 58, 109
- Edgewise appliance
 bracket positioning 59
 finishing 280
 second order (tip) bends 283
- Elastic chain 254
- Elastic retraction mechanics 99
- Elastic separators 66
- Elastics
 overbite control 138
 settling 294
- Elastomeric modules
 archwire ligation 20
 force levels 255–256
 space closure active tiebacks 255, 256–257
 trampoline effect 256
- Enamel footprints 310
- Enamel reduction cases 58
- Esthetic brackets 28
- Esthetic considerations in finishing 293
- Extraction series brackets 252
- Extraction site gingival overgrowth 259
-
- Facebows 143, 144
- Facial profile evaluation during finishing 293
- Facial tetragon (Fastlight) 174–175, 176
- Final adjustment appointment 308
- Finger and thumb appliances 143
- Finishing 280–296
 advantages of preadjusted appliance 280–281
 arch form 83, 289
 centric relation establishment 291
 cephalometric radiographs 293
 contact point 288
 curve of Spee final management 288
 definition 281
 dynamic considerations 291–292
 esthetic considerations 293
 functional movement checks 291
 horizontal considerations 282–287
 horizontal overcorrection 286, 287
 incisor crown-shape assessment 283
 incisor torque 284
 marginal ridge relationships 288
 MBT bracket system 21, 281
 posterior torque establishment 289, 290
 rotation control 285
 settling 294–295
 space closure maintenance 286
 temporomandibular joint function checks 292
 tooth fit coordination 282
influence of tip differential 283
 tooth size discrepancies 285
 transverse considerations 289–291
 transverse overcorrection 291
 vertical considerations 288–289
 vertical crown positions 288
 vertical overcorrection 289
- Follow-up phone call 113
- Force levels 3, 27
 anchorage needs relationship 99
 expression of tip 32
 extraction deep-overbite cases 139–140, 141
 McLaughlin and Bennett treatment approach 7
 MBT bracket system 8, 9, 12, 13
- space closure 252, 254–258, 259
 Straight-Wire Appliance (SWA) 4, 5
 Functional appliances 181
 Functional movements 291
-
- Gauges, bracket positioning 11, 59, 61, 62, 68
- Gingival overgrowth 61, 259
- Group movement of teeth
 extraction deep-overbite cases 139
 MBT bracket system 16
-
- HANT (heat-activated nickel-titanium) wires 13, 52, 77, 110
 arch leveling (torque issues) 136
 bendbacks 103
 clinical uses 110, 111
 ligation methods 20
 opening wires 112
 rectangular 78, 113, 136, 288
 thinning 103
 settling 294
 turning in ends 112
- Hawley retainers 314
- Headfilms 293
- Headgear
 Class II treatment anchorage support 172, 173
 lower arch retraction 261
 lower molar antero-posterior control 104
 upper molar antero-posterior control 105
 vertical control of molars in high-angle cases 107
- Herbst appliance 181
- High-angle cases
 Class I 175, 176
 curve of Spee final management 288
 vertical control of molars 107
see also Case reports
- High-pull facebows 143, 144
- Horizontal overcorrection 286, 287
- Hycon device 258
-
- Identification systems for brackets 28
- In-out specification 31
- Incisors
 agenesis of upper lateral 47
 anchorage control
 needs determination 96
 vertical 106
 antero-posterior position
 bendbacks for control 102–103
 evaluation during finishing 293
 bracket design requirements 5
 bracket positioning 60, 62
 chart individualization with abnormal incisal edges 64
 rotated incisors 61
 Class II treatment 166, 170–173, 174–176
 crown-shape assessment 283
 lower
 bracket zero tip 48
 Class III treatment 226, 232–234

Incisors, continued

- interchangeable brackets 48
- relapse prevention 83
- palatally displaced upper lateral 40-43
- planned position (PIP) 96, 162, 166
- proclination for deep-overbite correction 133
- retraction 250, 251
 - extraction deep-overbite cases 139
 - space closure 261
- torque 34-35
 - Class II lower incisor position 179
 - compensation 175
 - Fastlight's facial tetragon 174-175, 176
 - finishing 284, 293
 - treatment planning 162, 168, 226
 - triangular-shaped 58
- Individual arch form (IAF) determination 78, 79
- Inter-canine width 108
 - stability following expansion 72-73

- J' hook headgear 177
- Jockey wire 82, 290

Labial bonded retainers 313-314

- Lacebacks 7, 111
 - canine 139, 140
 - antero-posterior control 100-101
 - MBT bracket system 8, 15, 16
- Laser bracket numbering 28
- Lateral (coronal) anchorage support 108
- Leveling and aligning 94-113, 131
 - anchorage control *see* Anchorage control
 - Class II treatment 171
 - definition 94
 - extraction deep-overbite cases 139-140
 - mistakes in early preadjusted appliance systems 98
 - patient comfort/acceptance improvement 112-113
 - re-leveling procedures 109
 - short-term/long-term objectives 94
 - treatment sequence 95
 - wire sequencing 110, 111
- Ligature wires
 - lacebacks *see* Lacebacks
 - palatally displaced upper lateral incisors 40
 - settling 295
- Light-cured bonding/cementing materials 57
- Lingual arches
 - anterior open bite 143, 144
 - lower arch retraction 261
 - lower molar antero-posterior control 104
- Lingual bonded retainers 307, 312
- Lower arch relapse 317

McLaughlin and Bennett treatment approach 7

- see also* MBT bracket system
- Mandible
 - Class II treatment
 - condylar changes 181, 182, 183
 - functional appliances 181

- length changes 178, 180-182
- Class III displacements 219, 220
- inter-canine width, stability following
 - expansion 72-73
- plane evaluation during finishing 293
- Mandibular growth
 - Class II treatment 180
 - Class III treatment 233, 234
 - late growth 223, 234
 - length changes 180
 - orthopedic restriction 233
- Marginal ridge relationships 288
- Maxillary expansion 291
 - see also* Rapid maxillary expansion
- Maxillary growth 231
- MBT bracket system
 - .022 versus .018 slot 14
 - anchorage control in early treatment 15
 - anterior tip values 9, 15, 99
 - arch forms 12, 16
 - archwire hooks 18-19
 - archwire ligation methods 20
 - archwire selection 12
 - bracket positioning 11
 - accuracy 13
 - bracket selection 13
 - bracket system versatility 13
 - development from 1993-97 8-11
 - development from 1997-2001 12
 - finishing 21, 281
 - force levels 8, 9, 12, 13
 - group movement 16
 - tooth size discrepancies assessment 21
 - torque values 10-11
 - treatment philosophy overview 13-21, 27
 - working wires 13, 14, 17
- MBT Versatile+ bracket system *see* MBT bracket system
- Metal bracket removal 308
- Metal separators 66
- Mid-size metal brackets 28
- Mixed dentition cases
 - functional appliances 181
 - lingual arches 104
 - partial case set up 58
- Molar bands
 - anterior open bite 144
 - lower molar 67
 - overbite control 136
 - placement 66-67, 69
 - rapid maxillary expansion (RME) 66
 - removal 310
 - separation 66
 - upper molar 66
- Molar crossbites 108
- Molars
 - anchorage control
 - needs determination 96
 - vertical in high-angle cases 107
 - antero-posterior control
 - lower 104
 - upper 105, 106
 - attachments *see* Tubes
 - bracket positioning 60, 62
 - eruption of third 250, 251
 - extraction of second
 - anterior open bite 144
 - Class II treatment 173

- Class III treatment 224
- tip specification 32, 283
- torque 38
- treatment planning 162
- Multistrand wires 171
 - bendbacks 102, 103
 - opening wires 112
 - sizes/wire sequencing 110
 - turning in ends 112
- Myofunctional therapy, anterior open bite 143, 144

Nickel-titanium coil spring 257-258

- Nickel-titanium wires 110
- Nola Dry Field system 69

Open-bite cases

- bracket-positioning chart individualization 65
- vertical overcorrection 289
- see also* Anterior open bite
- Opening wires 77, 112
 - Class II treatment 171
- Oral hygiene 69, 310
- Overbite control 131
 - canine bracket selection 46
 - HANT/stainless steel wire use 111
 - see also* Deep-bite cases
- Overjet reduction, HANT/stainless steel wire use 111
- Ovoid arch form 12, 16, 74, 75, 76, 289
 - archwires 77, 78
 - assessment 77

Palatal bar

- anterior open bite 143, 144
- Class II treatment anchorage support 172, 173
- Class III maxillary retrognathism 220
- lower arch retraction 261
- maxillary expansion maintenance 291
- molar control
 - antero-posterior 106
 - vertical in high-angle cases 107
- Palatal bonded retainers 312
- Palatal expansion 46
 - anterior open bite 143
 - settling 295
- Palatal plate 295
- Partially erupted teeth 61
- Patient comfort/acceptance 112-113
- Patient post-treatment letter 316
- Periodontal ligament changes 307
- Planned incisor position (PIP) 96, 162
 - Class II treatment 166, 168-169
 - Class III treatment 226, 228
 - definition 162
 - treatment planning 162, 163
- Pliers 20
- Positioners 311
- Post-treatment consultation 316
- Post-treatment protocol 316

- Posterior bite plates
 anterior open bite 143, 144
 vertical control of molars in high-angle cases 107
- Preadjusted appliances
 Andrews' system 4–5
 finishing 280–281
 Roth system 6, 8
 wire sequencing 110
- Premolar extraction cases
 bracket-positioning chart individualization 65
 canine bracket selection 46
 Class II treatment 173
 deep overbite 138–141
 second premolars 262
 space closure 250
 space uses 250
see also Case reports
- Premolars
 bracket-positioning chart individualization 64
 brackets
 interchangeable 49
 positioning 60, 62
 small upper second premolars 31, 52
 tip specification 32
 torque 37, 38
 tubes 52
- Progress headfilms 293
-
- Rapid maxillary expansion
 arch form modifications 80
 mandibular inter-canine width stability following 73
 maxillary retrognathism management 220, 231
 molar band selection 66
- Reciprocal space closure 260
- Rectangular .019/.025 steel wires 14, 17, 33, 78, 110
 adaptation/customization 78
 bite-opening curves 137
 Class II treatment 172, 173
 space closure
 forces above recommended levels 259
 light forces 254, 256
 torque issues 136, 284
 upper arch expansion 81
- Rectangular HANT wires 78, 113, 288
 torque issues 136
- Rectangular steel wires 110
 sizes/wire sequencing 110
- Relapse 317
- Re-leveling procedures 109
- Removable acrylic plates 83
- Removable retainers 314–315
 vacuum-formed 315
 wire and acrylic 314
- Removal of appliance 307–311
 all-at-one-visit 308
 bands 310
 brackets 308
 cement/bonding agents 310
 enamel footprints 310
 final adjustment appointment 308
 positioners 311
- progressive removal 308
 white spots 310
- Respiratory problems, anterior open bite 142, 143
- Retention 307, 312–317
 arch form considerations 83
 bonded retainers
 labial 313–314
 lingual 307, 312
 palatal 312
 long-term considerations 317
 positioners 311
 removable retainers 314–315
- Reverse headgear 220, 231
- Rhomboidal bracket shape 29
- Roller coaster effect 13, 98, 139
- Rotated incisors 61
- Rotation control 285
- Roth appliance system 6, 8
- Round wires 77, 110
 bendbacks 103
 sizes/wire sequencing 110
 torque issues 136
-
- Settling 20, 294–295
 positioners 311
- Size of brackets 28
- Skeletal discrepancy evaluation
 Class II cases 164–165
 Class III cases 220
- Skeletal structures evaluation during finishing 293
- Sliding jig 58
 Class II treatment 173
- Sliding mechanics
 Class II treatment 172, 173
 space closure
 heavy (ex-edgewise) forces 252
 light forces 254–258
 spaces resistant to closure 258
- Soft tissue cephalometric analysis (STCA) 163
- Space closure
 anchorage control 260–262
 maximum anchorage cases 260, 261
 minimum anchorage cases ('burning anchorage') 262
 archwire hooks 19
 Class II treatment 172
 closing loop archwires 252
 elastic chain 254
 extraction deep-overbite cases 141
 HANT/stainless steel wire use 111
 maintenance 286
 methods 252–258
 obstacles 259
 over-rapid 252, 253
 premolar extraction cases 250
 reciprocal 260
 sliding mechanics
 heavy (ex-edgewise) forces 252
 light forces 254–258
 spaces resistant to closure 258
 space to relieve crowding 250, 251, 260
 upper lateral incisor agenesis 47
see also Case reports
- Space creation/stabilization
 archwire hook uses 19
- palatally displaced upper lateral incisors 40, 42, 43
- Split round tube, coil spring reactivation 41
- Square arch form 12, 16, 74, 75, 76, 81, 289
 archwires 77, 78
 assessment 77
- Standard size metal brackets 28
- Steel wires 13, 14, 77
 clinical uses 110, 111
 turning in ends 112
see also Rectangular .019/.025 steel wires
- Straight-Wire Appliance (SWA) 4, 27
 anterior tip specification 4, 8
 bracket positioning 59
 McLaughlin and Bennett treatment approach 7
 modifications 5
 'roller coaster effect' 5
-
- Tapered arch form 12, 16, 74, 75, 76, 289
 archwires 77, 78
 assessment 77
- Temporomandibular joint dysfunction 292
- Tiebacks 13
 active 255, 256
 Class II treatment 172, 173
 passive 255, 286
 space closure
 distal module 256
 extraction deep-overbite cases 141
 light forces 255–256
 maintenance during finishing 286
 mesial module 256–257
 nickel-titanium coil spring 257–258
 space stabilization 19
- Tip specification 4, 8, 9, 32, 99, 283
 anchorage control needs relationship 98, 99
 lower incisors bracket zero tip 48
 MBT bracket system 9, 15
 upper premolar bracket zero tip 49, 283
- Tomographic radiographs 219
- Tongue appliances 144
- Tongue habits 142
 positioners 311
- Tonsils removal 143, 144
- 'Tooth alignment' orthodontics 162, 219
- Tooth fit coordination 282
- Tooth size discrepancies 21, 61, 285
- Torque 5, 10
 arch form modifications 80
 canine 36
 expression inefficiency 33–34
 HANT/stainless steel wire use 111
 incisor 34–35
 Class II treatment 169, 173, 174–186
 compensation 175
 Fastlight's facial tetragon 174–175, 176
 finishing 284, 293
 palatally displaced upper lateral incisors 41
 overbite control 136
 posterior 289, 290
 premolar/molar
 lower 38
 upper 37
 specification 33–38
- Torque-in-base 29
- Torque-in-face 29

Trampoline effect 256
 Translation series brackets 252
 Transverse overcorrection 291
 Treatment efficacy 3
 Treatment goals, 280
 Treatment mechanics 3
 Treatment planning
 anchorage control needs determination 96
 Class II treatment 166–167, 180
 Class III treatment 219, 220
 ‘ideal’ incisor position 162
 limiting features 162, 163
 surgical/non-surgical treatment 163
 tooth size discrepancies assessment 21
 True vertical line (TVL)
 Class II case assessment 168
 Class III case assessment 220, 221, 222, 223
 Tubes
 bondable mini tubes 54
 molar bands placement 67
 non-convertible 53, 67

 use for upper molars of opposite side 51
 lower second premolar 52
 upper molar
 molar bands placement 66
 triple tube 53
 use of second molar tubes on first molars 50
 see also Bracket system versatility
 Twinblock appliance, Class II/1 treatment case report 198–205

Unerupted teeth 109
 Unwanted tooth movements 94
 Up-and-down elastics 19
 Upper arch expansion
 arch-form settling phase 83
 archwires 81
 jockey arch use 82
 see also Palatal expansion; Rapid maxillary expansion

Upper arch relapse 317

Vacuum-formed retainers 315
 Vertical anchorage control 106–107
 canines 107
 incisors 106
 molars in high-angle cases 107
 Vertical chin cups 143, 144
 Vertical crown positions 288
 Vertical overcorrection 289
 Vertical triangular elastics 294

Wax bite 219
 Wax templates 289
 Wax, use by patients 112
 White spots 310
 Wire and acrylic retainers 314
 Wires *see* Archwires